SCIENCE ABSTRACTS.

Section A.—PHYSICS.

AUGUST 1921.

GENERAL PHYSICS.

1346. *Differential Equation Occurring in Physics.* **T. Hayashi.** (Tôhoku Univ. Sci. Reports, 10. pp. 43–55, March, 1921.)—The equation considered is $(1 - x^2)d^2y/dx^2 = (a + bx^2)y$. Various particular cases are discussed and solutions given for some. A. W.

1347. *Experiments with a New Form of Impact Test-Piece.* **L. Guillet.** (Rev. de Mét. 18. pp. 221–224, April, 1921.)—There are three principal forms of test-piece used in making impact tests, in all of which the specimen is 10 × 10 × 55 mm. In the Mesnager test-piece, the notch is 2 × 2 mm. and is rounded at the base, in the Charpy test-piece a 1·3-mm. diam. hole is drilled tangentially to the long axis, and is joined up to the side by a 1-mm. saw cut, while in the official test-piece of the "Commission de Standardisation" the notch is 2 mm. wide and 5 mm. deep, the end having a 1-mm. radius. The Charpy test-piece is said to give too low a value for the shock resistance in non-brittle materials, while the Mesnager test-piece often fails to fracture when the material has a high shock resistance. In tests carried out on various steels by all three methods it was found that the "official" test-piece broke more frequently than the Mesnager test-piece [but see next Abstract], and that the impact figures obtained approach much more closely to those obtained by the Charpy test than to those obtained by the Mesnager test. J. L. H.

1348. *Notched-Bar Impact Tests.* **Legrand.** (Rev. de Mét. 18. pp. 225–228, April, 1921.)—A series of tests were made on samples of a mild steel and a 2 % nickel steel to investigate the differences between the impact figures given by the use of the Mesnager test-piece and the test-piece recommended by the Commission Permanente de Standardisation (known as the U.F. test-piece) [see preceding Abstract]. The results showed that the Mesnager test-piece gave a much higher figure than the U.F. test-piece, while the latter were much more likely not to break than the former. J. L. H.

1349. *Strength of Cast Iron in Bending as Affected by Variations in Cross-Section.* **J. H. Billings.** (Univ. of Toronto, Eng. Research School Bull. No. 1. pp. 109–114, 1919.)—A series of sections were cast from an iron containing C 3·33 %, Si 2·33 %, Mu 0·49 %, S 0·10 %, and P 0·09 %. Taking the factor of rupture as the ratio of the modulus of rupture to tensile strength (the modulus of rupture is the term f_b in the bending formula $M_b = I/c \, . f_b$) the following results were obtained :—

Shape of Section.	Rupture Factor.
Rectangular	1·5
Round	2
Uniform I....................	1·2
Non-uniform I	1

The economy factors, namely, max. bending moment in lbs. ft. divided by the area of cross-section in sq. in. were : 600–1700, 629, 2230, and 2300. F. C. T.

1350. *Mirror Extensometer Tests at High Temperatures.* **H. Edert.** (Stahl u. Eisen, 41. pp. 510–511, April 14, 1921. Engineering, 111. p. 600, May 13, 1921.—Abstract.)—The cylindrical electric furnace surrounding the test-piece is of the Stribeck type. The levers, knife-edges, and clips are made of chromin, a chrome-nickel steel of the Nickelwerke at Schwerte, which can be forged and machined like ordinary steel and will bear 1000° C. The upper pair of knife-edges and the mirrors are mounted above the furnace and are kept cool by a gentle air current from two nozzles fixed obliquely to one another in the same horizontal plane below the mirrors. Experiments can be continued at 850° for several hours. H. B.

1351. *Effect of Temperature on the Rigidity and Viscosity of Solid Metals.* **K. Iokibê** and **S. Sakai.** (Tôhoku Univ. Sci. Reports, 10. pp. 1–27, March, 1921. Forty-fifth Report of the Iron and Steel Research Institute.)—The authors describe an apparatus for measuring the modulus of rigidity and the coefficient of viscosity of metals in the form of wires by measuring the period of swing and the logarithmic decrement of a system supported by the wire under observation. Thirteen different metals were examined, and it was found that, as the temperature rises, the rigidity decreases according to a parabolic law : in the case of metals having low melting-points this decrease is very rapid ; with metals having high melting-points, however, the initial diminution is small, but as the temperature rises, it becomes more and more rapid. The log. decrement increases with rise of temperature except in the case of high-melting-point metals, where it decreases at first and afterwards rises rapidly. In ferromagnetic substances both the decrement and the rigidity are affected by the magnetic transformation. J. L. H.

1352. *The Phenomena of Rupture and Flow in Solids.* **A. A. Griffith.** (Roy. Soc., Phil. Trans. 221. pp. 163–198, Oct. 21, 1920.)—Scratches only 10^{-4} in. in depth increase locally the max. stress 3 to 4 times and this produces local yielding at stresses far below that corresponding to the elastic limit of the unscratched material. Thus the ordinary hypothesis of rupture cannot safely be employed to predict the safe range of alternating stress for scratched materials. Rupture will occur where as a result, a diminution in the potential energy of the specimen is found. In the case of thin plates of glass the max. tensile stresses found at the corners of the cracks may be more than ten times as great as that of the material as ordinarily measured. Rods and pieces of fused glass and quartz have been prepared which have a tenacity of 10^6 lbs. per sq. in. This high value decreases with time, probably as the result of the formation of cracks. A theory is developed to explain these phenomena, based on the surface energy produced as a result of the cracks. It should be possible to raise the yield-point and tensile strength almost to the theoretical strength and correspondingly increase the fatigue range. A thin film of liquid between solid boundaries which are wetted should act as a solid. F. C. T.

1353. *A New General Law of Deformation.* **P. G. Nutting.** (Frank. Inst., J. 191. pp. 679–685, May, 1921.)—Reference is made to Hooke's law and to Poiseuille's law, and their general applicability discussed. Michelson's investigations of the yielding of solids under torsional shearing stress are mentioned as resulting in extremely complex expressions. In order to obtain precise data upon which to formulate a law applicable to slowly yielding media, the author studies deformation in pitch-like substances subjected to pure coplanar shearing stresses. The general formula arrived at is $s = at^nF^m$ in which n and m are independent of s the deformation, t the time, and F the force applied, but are functions of the temperature. They are also independent of the dimensions of the test-piece, of the units employed, and of the method of test so long as a pure shear only is involved. a is a constant independent of s, t, and F, but depending on the units and method employed. The old laws of elastic deformation and of viscous deformation are special cases of this law in which $n = 0$, $m = 1$, and $n = 1$, $m = 1$, respectively. Experimental values of n are stated to have been found as low as 0·2 and as high as 0·91, and of m from 0·74 to 3·5. Alternative forms of the general deformation law are given and discussed. The general formula is applied to electrical conduction and tentative expressions are given, of which Ohm's law is a special case corresponding to pure viscosity in fluid motion. The flexibility and generality of the new formula are illustrated in a number of examples. A. B. C. L.

1354. *Weldability of Solid Powders by Pressure.* **T. v. Hagen.** (Zeits. Elektrochem. 25. pp. 375–386, Dec. 1, 1919.)—Experiments are made with a great number of pure inorganic substances (oxides, salts, sulphides, quartz, graphite), both hydrated and anhydrous, to ascertain whether they can be compressed to cohesive tablets or cylinders, and how appearance, hardness, and strength of the product depend upon the melting-point, hardness, grain size of the material, and upon the pressure, nature of binding agent (mostly water) and other conditions. The materials were powdered (25 meshes per sq. mm.) and subjected generally to a pressure of 500 kg./cm.^{2}, small cylinders (0·5 gm. or less) being formed; in special experiments the pressure was raised from 560 to 9800 kg./cm.^{2}. The crushing tests of the products were pushed up to 230 kg./cm.^{2}; harder tablets were tested by the sclerometer. The materials are distinguished as not-weldable (nicht pressbar), powdery, smooth, homogeneous, plastic. Soft materials (hardness up to 1·5 Mohs) are generally plastic, with hardness 1·5 to 2·5 homogeneous or smooth. Fine grains cohere better than coarse grains; the water (also of crystallisation) is of influence, but there is no simple quantitative relation; the formation of special hydrates is not studied. As the melting-point rises, the weldability (Pressbarkeit) decreases. The alkali and other halides and ($CaCl_2 + H_2O$) give very cohesive products; hydrated sulphates, etc., are also cohesive, the anhydrous salts not; oxides give powdery bodies of low strength. Quartz and barium sulphate do not cohere at all. The density increase with pressures may be regular (kaolin, up to 7000 kg./cm.^{2}) or more rapid at first than later; homogeneous bodies soon reach a maximum density. In general weldability and plasticity (depending upon the number of gliding planes) go together. H. B.

1355. *Viscosity Measurements.* **O. Faust.** (Zeits. phys. Chem. 93. pp. 758–761, Dec. 2, 1919.)—In determining the viscosity of highly-viscous materials by the method of Cochius, an air bubble is introduced into a vertical tube, about 50 cm. high, and the rate of ascension of the bubble is measured. In such tests the width of the tube is not stated, as a rule. The author shows that for fairly wide tubes (15 to 21 mm. diameters) the tube diameter should be, and is, of no influence, and that in such tubes the size of the bubble is also immaterial, provided the bubble be approximately cylindrical and not pointed. In narrow tubes slight discrepancies may arise, because the bubble diameter $2r_1$ is a little smaller than the tube diameter $2r$, so that $(r + r_1)$, a sum entering into the calculations, is not quite equal to $2r$. H. B.

1356. *On the Theory of Sliding and Rolling Resistance of Solid Bodies.* I. *Sliding Friction.* **A. Fuchs.** (Phys. Zeits. 22. pp. 173–177, March 15, 1921.)—The nature of sliding friction has remained an open question up to the present. Numerous investigations recently undertaken, however, have shown the great influence which the surrounding atmosphere exerts on the friction phenomena. The author now attempts to answer in the affirmative the problem stated by Klein and Sommerfeld—namely: "Is it possible from a physical consideration of dry friction to regard the air layer between the surfaces in contact as a species of lubricant, and so be in a position to apply the friction laws of the kinetic theory of gases?" The condensation of gases at the surfaces of solid bodies is an established fact, and the density of this gaseous layer varies with the pressure, so that at very low pressures its influence on the kinetic gas phenomena at the surface tends to disappear. This line of attack is adopted by the author. Jakob's experiments are quoted as showing that with artificial layers of alcoholic solutions of oil, the friction could be regulated below Coulomb values, but the present author opposes the conclusion drawn by Jakob, that the friction does not depend on invisible lubricant layers, with the affirmative. Experiments at different temperatures are cited. The author opines it to be no accident that the curve showing the connection between friction coefficient and velocity has the same form for the sliding position with lubricant as with dry friction, *i.e.*, first a decrease in the coefficient with increasing velocity to a minimum, and then an increase. For the case when the transition velocity by oil friction is fairly small when with air it is relatively high, the cause is to

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be sought in the small-viscosity gas constant as against the corresponding value for the viscous liquid. H. H. Ho.

1357. *On the Theory of Lubrication.* **A. Sommerfeld.** (Zeits. techn. Physik, 2. 3. pp. 56–63, and 2. 4. pp. 89–93, 1921.)—Section 1 deals with dry friction. After a comment on the simplicity and accuracy of the Coulomb law, the author refers to experiments by Kaufmann and Jacob which appear to show that with extreme polish and purification of the surfaces the whole of the differences between the frictional phenomena of rest and motion vanish. Section 2 considers fluid friction and lubrication. Section 3 investigates the similarity law for lubricator friction. In section 4 two proofs of the similarity law are discussed, and Stribeck's experimental work is dealt with at some length. Section 5 describes the main features of the hydrodynamic lubrication theory, and considers cases where the lubricant adheres to the surfaces, where the space between the surfaces is completely full of lubricant, and the effect of pressure differences and flow. Section 6 contains the quantitative consequences of the hydrodynamic theory. Recent work on lubricants by Rayleigh is discussed in section 7. The author concludes by a reply to Gümbel's objections, which were raised from the practical standpoint. H. H. Ho.

1358. *Photography of Projectiles.* **F. Hauser.** (Zeits. wiss. Phot. 20. pp. 257–272, May, 1921.)—For investigating the phenomena of the flight of a projectile the interference refractometer of L. Mach was used. A description is given of the experimental arrangements and method and a number of photographs of bullets in flight are reproduced. These show a multitude of interference bands crossing the wave-fronts, and from the shape of these bands the pressure distribution about the bullets can be deduced at once. A. W.

1359. *Equations of Motion of a Single Particle.* **J. H. M. Wedderburn.** (Roy. Soc. Edinburgh, Proc. 41. 1. pp. 26–33, 1920–1921.) The treatment is mainly mathematical. The conclusions are compared with the Newtonian and Einstein forms. A. B. C. L.

1360. *Production of Vortices in Liquids; Theoretical Discussion of their Origin.* **G. Jaffé.** (Phys. Zeits. 22. pp. 541–543, Oct. 15, 1920.)—The author discusses theoretically the production of vortex motion in fluids. He first points out that the origin of vortex production is often attributed to friction, whereas under the Helmholtz law no vortices can arise in either a frictionless or a viscous liquid. What is really required for the production of vortices is a definite distribution of the external forces. It is not necessary, for instance, that there should be present a resultant external moment; all that is needful is that the line-integral of the force along each closed curve in the liquid shall not vanish. L. H. W.

1361. *Rotating Fluids.* **G. I. Taylor.** (Cambridge Phil. Soc., Proc. 20. pp. 326–329, May, 1921.)—Describes the results of some experiments on motion in a rotating fluid, showing that all small steady motions of a rotating fluid, relative to the rotating system, must be two-dimensional. It is also shown that there is no force tending to rotate a solid sphere moving along the axis of rotation of a rotating fluid. The stability of fluid motion between two concentric cylinders is also discussed, and Rayleigh's condition for stability of the disturbances is found to be true at high-speed rotation, but is very considerably modified at low speeds, presumably on account of viscosity. J. W. T. W.

1362. *Movement of the Centre of Gravity of a Symmetrical Solid with Respect to a Vertical Plane displaced in a Resistant Medium.* **Alayrac.** (Comptes Rendus, 172. pp. 1089–1092, May 2, 1921.)—The formulæ generally employed in the resolution of this problem assume the movement to be rectilinear and uniform. It is shown by the study of the differential equation of the movement that rectilinear movement is only stable under certain conditions. The treatment is mathematical A. B. C. L.

1363. *Discontinuous Flow of Liquid past a Wedge.* **W. B. Morton.** (Phil. Mag. 41. pp. 801–808, May, 1921.)—The case of two-dimensional motion solved by Bobyleff, in which a wedge is set in an infinitely extended stream in such a way that a stream line divides at the apex of the wedge and runs along the two sides into the two surfaces of discontinuity which extend to infinity, is referred to. It requires, for a wedge of given angle set in a given manner relative to the stream, that the breadths of the two sides should be in a definite ratio. The problem is investigated as to the character of the motion when this ratio is departed from. To obtain the conditions of the problem a single plane lamina is set at angle α to the direction of the stream and a second plane built out from the upstream edge of the first at angle β until it reaches the free surface of the liquid. The conditions subsequently obtaining are discussed and developed mathematically for the special case of a right-angled wedge and for the general case of a wedge of any angle. The resulting integrals are calculated and the breadth-ratios plotted as curves from which the constants involved are deduced for a number of cases. A. B. C. L.

1364. *Effect of Waves on Transverse Stability.* **G. R. Edgar.** (Inst. Eng. and Shipbuilders, Trans. 64. pp. 42–57; Disc., 57–59, Dec., 1920.) —The treatment requires for its comprehension the study of stability and G Z curves given in the original paper and is unsuitable for abbreviation. L. H. W.

1365. *The General Spherically Symmetrical Solutions of the Einstein Gravitational Equations in Vacuo.* **J. T. Jebsen.** (Ark. f. Mat., Astron. och Fysik, Stockholm, 15. No. 18. [pp. 1–9] 1921.)—In Einstein's general theory of relativity, the spherically symmetrical static case of Schwarzschild and Hilbert has been exactly solved. The present paper deals with the non-static spherically symmetrical case according to the method used by Hilbert. From the mathematical standpoint it was to be expected that in this general case new solutions of the differential equations would be given which would also be more general. This was also to be anticipated on physical grounds, since many phenomena occur in nature which are spherically symmetrical but not static. It is found that in this general spherically symmetrical case, the same solutions are given as in the statical case by a suitable choice of the time coordinate. This circumstance is found to apply to all four of Einstein's hypotheses. H. H. Ho.

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1366. *Comparison of a Theory of Classical Dynamics and the New Gravitational Theory of Einstein.* II and III. **A. V. Bäcklund.** (Ark. f. Mat., Astron. och Fysik, Stockholm, 15. No. 14. [pp. 1–22] and No. 17. [pp. 1–12] 1921.)—Part II of this investigation first clears up some of the difficulties raised in Part I and then deals with Einstein's hypothesis on the curvature of light rays and its place in the author's theory. Part III considers spectra and completes the comparison between the two theories. The two papers are entirely mathematical. H. H. Ho.

1367. *Note on Rotation in the Stellar Gravitational Field.* II. **A. Kopff.** (Phys. Zeits. 22. pp. 179–183, March 15, 1921.)—A previous deduction of the centrifugal and Coriolis forces which occur in the rotating coordinate system [*ibid.*, p. 24, 1921] depends on the first approximation of the equations of motion in the general theory of relativity. The author now demonstrates the same result by a more difficult method based on the solutions obtained by W. de Sitter [see Abs. 134 (1918)] for the Einstein gravitational equations extended to the case of a closed elliptic space. The former demonstration has the advantage of showing more easily how the forces are dependent on the gravitational field of static matter. In consequence of the general invariance of the gravitational equations and those of motion, the same forces occur when the rotating system is considered to be at rest and the external masses to be rotating. H. H. Ho.

1368. *Notes on the Theory of Relativity.* **O. Meissner.** (Phys. Zeits. 22. pp. 183–186, March 15, 1921.)—The author opines that to acquire clarity on this subject it is necessary to determine exactly to which position in the Comte-Ostwald scheme the relativity principle belongs. A large part of the dispute appears to depend on the rank of this principle. The discussion is mainly philosophical, and the author, while accepting the curvature of light rays in consequence of the strong gravitational field of the sun, disputes the curvature of space. To him it is impossible to speak simultaneously of a bending of space and of rays of light. The Euclidean idea of space is dealt with at length, and it is shown that with a true non-Euclidean space, the universe would be a part of at least a 5-dimensional space–time conception. The author opines that the term "ether" is really Einstein's space, and that the usual term "space" refers to a mathematical abstraction. Inertia and gravitation are briefly examined. The author, however, while very critical and destructive would not reject the theory of relativity, since it affords a common explanation for many remarkable phenomena, which, while capable of separate alternative explanations cannot otherwise be grouped together under a single theory. The final form of the theory, however, has not yet been obtained. H. H. Ho.

1369. *Application of Einstein's Theory of Gravitation to a Stationary Field of Gravitation.* **H. A. Kramers.** (K. Akad. Amsterdam, Proc. 23. 7. pp. 1052–1073, 1921.)—Section 1 of this paper contains the definition and invariant properties of a stationary field of gravitation. Section 2 deals with the field of gravitation which is produced by stationarily moving masses. Section 3 investigates the influence of a stationary field of gravitation on the motion of a rigid body round its centre of gravitation. Section 4 examines the influence of the field of gravitation of the sun on the rotation of the earth. It is found that if a rigid body is situated in a stationary field of gravitation with its centre of gravity at rest, the Poinsot-motion, which the body in the absence of the field of gravitation would perform in the way well known from classical mechanics, will be disturbed by a superposed uniform rotation which is independent of the properties of the body, and at the same time by the influence of a conservative field of acceleration: an influence, which is closely connected with the properties of the body. The "own" field of gravitation of the body will—in first approximation—have the effect that all quantities, which characterise the position and the just-mentioned perturbations in the motion of the body, will undergo small modifications proportional to the mass of the body. It has also been found that, in confirmation of an idea for the first time put forward by Schouten, the gravitation theory of Einstein leads to the result, that theoretically there will exist a contribution to the value of the precession of the rotation axis of the earth, which did not appear on Newton's theory. This is independent of the constitution of the body of the earth, and amounts to a progressive precession of 0·019 second of arc annually. H. H. Ho.

1370. *On a Recent Extension of the Basis of the General Theory of Relativity.* **A. Einstein.** (Preuss. Akad. Wiss. Berlin, Ber. 12. pp. 261–264, 1921.)—Weyl has recently sought to extend the general theory of relativity by the introduction of a further condition of invariance, and has thereby arrived at a theory which has aroused great interest on account of its bold logical and mathematical conceptions. This theory is based essentially on two ideas: (1) In the general theory of relativity a physical significance must be ascribed to the ratio of the components of gravitational potential, as great as that given to the components themselves. (2) A generalisation of the Riemann metric, which, while retaining the existence of transferable measuring rods rejects the independence of these lengths on the mode of transfer. The author, however, is not satisfied with the physical validity of Weyl's considerations, and he shows that a theory may be derived based solely on the invariant significance of the equation, $ds^2 = g_{\mu\nu} dx_\mu dx_\nu = 0$, without including the idea of the length ds, that is, without involving measuring rods and clocks. H. H. Ho.

1371. *Newtonian Field in Neighbourhood of an Assigned Vector Field.* **O. Onicescu.** (Accad. Lincei, Atti. 29. *i.* pp. 181–185, March 7, 1920.)—A discussion of this problem in its application to the theory of magnetic induction. The paper is mainly mathematical and cannot be usefully abstracted. J. W. T. W.

1372. *Ether and the Quantum Theory.* **H. S. Allen.** (Roy. Soc. Edinburgh, Proc. 41. 1. pp. 34–43, 1920–1921.)—The principal theories and researches on the subject are reviewed and discussed, and it is suggested that results harmonise with the view that the "quantum" is itself essentially magnetic. A. B. C. L.

1373. *Direct Measurement of the Thermal Molecular Velocity.* **O. Stern.** (Zeits. f. Physik, 3. 5. pp. 417–421, 1920.)—The author deals with the objection raised against the assumption made in his previous paper [Abs. 25 (1921)] that the atoms leaving the silver surface have

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the same velocities as those of molten silver, and modifies his calculations to some extent. Further measurements of the mean velocity of silver atoms, made with higher rotational velocities, give values lying between 584 and 672 metres per sec. T. H. P.

1374. *Foundations and Aims of Bohr's Theory of Atoms and Spectra.* **A. Sommerfeld.** (Zeits. Elektrochem. 26. pp. 258–260, July 1, 1920. Paper read before the Bunsen Gesell., Halle, April, 1920.)—A review of Bohr's theory, with special regard to series lines and their quantum relations, to the author's refinement of the theory with respect to doublets by substituting planetary elliptical orbits for the circular orbits and by adopting the mechanics of the relativity principle, and to the character of the vibrations. So far the structure of the hydrogen atom is alone known; the structure of the helium atom is still contested, Bohr's model improbable; the Bohr-Debye model of the hydrogen molecule is certainly wrong. H. B.

1375. *Structure of the Atoms and Röntgen Spectra.* **E. Wagner.** (Zeits. Elektrochem. 26. pp. 260–262, July 1, 1920. Paper read before the Bunsen Gesell., Halle, April, 1920.)—A summary. Whilst in the case of hydrogen the various Bohr orbits signify various possible quahta for the one electron, the first ring of other atoms corresponds to one quantum, the second ring to two quanta, etc. The K series is emitted when an electron passes from an outer ring to the first, K_α starting from the second ring, K_β from the third, etc., the rings being assumed to be fully set with electrons (Kossel). Moseley's formula for the connection between frequency and ordinal number holds approximately; a closer agreement was observed by Kroo for the K_α frequency, but this fails (Smekal) for the L_α frequency, whilst Sommerfeld has successfully explained the structure of the L lines. There is no room for any element (coronium ?) between hydrogen and helium, though the Röntgen spectra of the first 10 elements (H to Ne) are unknown and are not determinable by the crystal method because their wave-lengths are too large, and no probability either of other unknown elements except those to fill up the five recognised gaps. The study of Röntgen spectra is the most promising for the elucidation of the quantum structure of the atom. H. B.

1376. *The Binuclear Atomic Theory and the Disintegration of Nitrogen.* **O. Hinsberg.** (Chem. Zeit. 44. p. 294, April 15, 1920.)—The author had proposed (J. prakt. Chem. 1919, p. 99) that the elements of the groups V to VIII of the periodic table had two atomic nuclei or valency centres. Rutherford having shown that α-ray bombardment ejects hydrogen from nitrogen, apparently from a region remote from the principal nucleus of the nitrogen atom, the author suggests that the helium-nucleus of R in the nitrogen atom is identical with the tetravalent nucleus of his (H), whilst the positively charged hydrogen comes from the monovalent nucleus of H. H. B.

1377. *Relation between the Growth Forms and the Structure of Crystals.* **P. Niggli.** (Zeits. anorg. Chem. 110. pp. 55–80, Feb. 24, 1920.)—Development of views explained in the author's book on "Geometrische Kristallographie des Diskontinuums." The common faces preferentially developed on crystals are normal to the directions of minimum velocity of growth. An attempt is made to bring these directions in relation to the structure of the crystal, the velocity of growth and the distance between consecutive atomic layers. There is not simply an inverse proportionality; that is manifest because growth and dissolution are not strictly reciprocal. The author considers especially the influence of chemical or affinity valency, admitting that the phenomena are more complex. In a crystal like rock-salt, the atoms of unsaturated affinity will in a crystal face all lie in the boundary plane, if this be a cubic face plane. For any other oblique plane the unsaturated atoms will not be in a face plane, but in a layer of thickness A, which will be asymmetrical to the grouping of the atoms; the affinities then suggest growths in steps. The smaller the A, the more stable the secondary faces. The problems are discussed with respect to the various crystal faces observed in rock-salt and to the larger number of faces observed in galena (also cubic) and also for gold; experiments on the rates of growth and of dissolution and the frequency of certain faces support the arguments [cf. Valeton, Abs. 776 (1921)]. H. B.

1378. *Modification of Bohr's Atomic Model.* **F. Kirchhof.** (Zeits. phys. Chem. 93. pp. 623–633, Sept. 26, 1919.)—Modifying suggestions of Debye, which A. Meyer's floating magnets illustrated, so as to make them more adaptable to the periodic table, the author suggests that the outermost ring can never contain more than 8 electrons, and that the number of (electrons plus atoms) in that ring can never exceed 8 either. Thus the C and Si atom can still take up 4 electropositive atoms each, F only 1, Ne and A none at all. The main valency is hence the difference (8 − the number of electrons in the extreme ring); that would account for Abegg's rule that the sum of the main and of the counter valencies is always 8. The author applies his considerations to the K, L, M series and to radio-active phenomena. H. B.

1379. *The Atomic Weight of Hydrogen and Prout's Hypothesis.* **A. Bilecki.** (Zeits. anorg. Chem. 110. pp. 335–338, April 29, 1920.)—Calculations to show that the atomic weight of oxygen must be an exact multiple of that of hydrogen. The author had previously deduced a fundamental factor $n = 0\cdot\dot{3}07692\dot{3}$. If O : Ag = 16 : 108, then $\frac{1}{40}$th $n = 0\cdot00\dot{7}69230\dot{7}$. From the density determination by various experimenters of hydrogen and the H : O ratio he finds H = 1·0077, if O = 16, and the fraction 0·0077 has the same value as $n/40$. H. B.

1380. *The Structure of the Capillary Layer.* III. **G. Bakker.** (Zeits. phys. Chem. 93. pp. 570–584, Sept. 26, 1919.)—As in [Abs. 284 (1916)] the author assumes a plane so placed in the capillary layer, parallel to its boundary surface that, if the capillary layer were removed and the liquid and vapour phases were continued up to that plane, the total mass would not alter. In that case the capillary layer would have been formed out of the homogeneous phases of liquid and vapour, without altering the total mass and the total volumes. With the aid of the formulæ in the molecular pressure of Laplace, Clausius, and Sarrau, the author calculates the number n of the original molecular layers (both liquid and vapour) in the layer, n_1 the number of new layers and ζ the thickness of the capillary layer. These quantities change with the temperature t

as follows: CO_2; $t = -25$; 0, 20, 28, 30°; $n_1 = 4 \cdot 8, 5 \cdot 4, 8 \cdot 8, 13 \cdot 3, 28$; $n = 4 \cdot 3, 5 \cdot 1, 8 \cdot 6, 13 \cdot 2, 28$; $\zeta = 2 \cdot 6, 2 \cdot 9, 4 \cdot 8, 7 \cdot 2, 15\ \mu\mu$; benzene: $t = +5 \cdot 4$, 80, 200, 250, 280°; $n_1 = 3 \cdot 8, 5, 5 \cdot 8, 8 \cdot 3, 17 \cdot 8$; $n = 2 \cdot 9, 4 \cdot 2, 4 \cdot 7, 5 \cdot 4, 8, 17 \cdot 7$; ether: $t = 0$, 50, 120, 170, 19·3°; $n_1 = 4 \cdot 2, 5 \cdot 1, 7, 7 \cdot 6, 24 \cdot 5$; $n = 3 \cdot 4, 4 \cdot 4, 6 \cdot 4, 9 \cdot 3, 24 \cdot 5$. The ζ values of CO_2 are more than a unit larger throughout than in his previous calculations.

H. B.

1381. *Anisotropic Liquids.* **J. S. van der Lingen.** (Frank. Inst., J. 191. pp. 651–677, May, 1921.)—Previous work on the optical properties of solid crystals and anisotropic liquids is reviewed and the theories of anisotropic liquids are discussed at length. It is shown that (1) the magnitude of Bose's swarms must be reduced in order to agree with the observations on the rate of efflux through narrow capillary tubes, (2) either Eötvos' theory must be modified so as to include anisotropic liquids, or Bose's theory must be dropped. Bose and Lehmann deny that pseudo-isotropic liquids have a space-lattice, whereas Vorländer definitely states that they are uniaxal crystals even though the forms are doubtful and their elasticities vanishingly small. M. v. Laue's recently devised method of research by Röntgen rays is excellently suited for the experimental determination as to which of the two structures answers to the facts. In this connection, the relationships of X-rays to crystal structure are discussed. The substances selected for experimental work are (*a*) *p*-azoxy-anisole, (*b*) *p*-azoxyphenetole, (*c*) anisaldazine, (*d*) Stumpf's cyanester. The apparatus employed for effective microscopic and photographic examination of these substances when subjected to suitable heating arrangements is described and illustrated, and the method of experiment given. The results show that the pseudo-isotropic layers of Lehmann and Bose are not crystallographically homogeneous, nor is there any evidence that such layers are microcrystalline. It is concluded that the experiments show that such layers of anisotropic liquids do not possess a space-lattice; *i.e.*, Vorländer's contention, based on optical phenomena, cannot be accepted. A. B. C. L.

1382. *Nomogram for Sunlight Engineering.* **W. H. Herbert.** (Roy. Astron. Soc. Canada, J. 15. pp. 138–145, April, 1921.)—It is important in designing windows, buildings, and streets to arrange for obtaining the requisite amount of sunshine. The author gives notes of previous tables dealing with the determination of the azimuth and altitude of the sun for any hour, day, and latitude, and points out inconveniences in working with them. He then sketches his own nomogram, which, he claims, is immediately applicable to any latitude, and describes the method of use, with a numerical example. He also suggests other problems, such as navigation, or construction of sun-dials in which his graphic solution of the usual spherical triangles may be employed with a slight modification. W. W. B.

1383. *Comparability of Anemometers.* **C. E. Brazier.** (Comptes Rendus, 172. pp. 843–845, April 4, 1921.)—The ratio of the mean wind speed over periods of the order of an hour, as measured by anemometers of different types erected near one another and equally exposed, is found to vary from one occasion to another. The author finds that the explanation lies in the complex structure of the wind and the different percentage of the horizontal component of an inclined air current which is recorded by the various types of anemometer. The results of experimental work are expressed in a table which shows for eight different instruments the ratio of the measured to the actual horizontal component of an air current inclined to the horizontal at 10°, 20°, 30°, etc., up to 80°. These instruments comprise a Dines pressure-tube, square vertical plate, 3 Robinsons with equal cups but arms of various lengths, 2 similar instruments with hemicylindrical cups (in one perpendicular to arms and in the other radial), and finally a Richard. The principal conclusions derived from this table are as follows:—(1) The different types of anemometer, though standardised in the laboratory, will not give comparable readings if the inclination of the complex currents constituting the wind exceeds 10°. (2) When eddies with a marked vertical component are frequent, (*a*) the Richard instrument reads too low whilst the others are in general too high, (*b*) the excess shown by the Robinson is the greater, the less the ratio of the radius of the cups to the distance of their centres from the pivot, (*c*) the instruments giving readings closest to reality are the Richard and the Robinson with short arms (above-mentioned ratio 0·5 to 0·8), (*d*) up to inclinations of ± 50° a value within 5 % of the real value may be obtained by taking the mean of the readings of the Richard and the Robinson (cups of diameter 61·5 mm., distance between centres of opposite cups 122 mm.), (*e*) if a single instrument is to be employed the Richard is best, this particular Robinson next, (*f*) the result of standardising instruments of different types by comparison with a single one under natural conditions is only valid under the conditions in which the comparison was made. M. A. G.

1384. *Comparison of Diffuse and Direct Solar Radiation.* **J. Vallot.** (Comptes Rendus, 172. pp. 1164–1167, May 9, 1921.)—Employing Arago and Michelson actinometers, the latter for direct solar radiation, determinations were made at Nice, hourly from 8h. to 16h. on 30 clear days distributed throughout the year, of I_s, the intensity of direct solar radiation, I_t, the total radiation, and $I_{t'}$, the total radiation diminished by I_R; where I_R is the amount reflected from the earth's surface. From these are deduced $I_d = I_t - I_s$, $I_r = I_t - I_{t'}$, and $I_c = I_{t'} - I_s = I_d - I_r$. The diurnal and seasonal variation of all these quantities and of the ratios I_t/I_s, I_d/I_s, I_c/I_s and I_r/I_t are exhibited in tabular form. The last ratio is found to increase slightly with the height of the sun, but never to reach the value 0·1. The chief result is, however, the considerable magnitude of the ratios I_d/I_s and I_c/I_s. On clear days the former is on an average as large as 0·33, and the latter 0·23. On cloudy days these ratios would of course be greater. M. A. G.

1385. *Variations in Solar Radiation at Bagnères-de-Bigorre, during the Solar Eclipse, April* 8, 1921. **Dort.** (Comptes Rendus, 172. pp. 1116–1117, May 2, 1921.)—Measurements were made with a Violle actinometer and the records published show that at max. eclipse the intensity of solar radiation was reduced to about a quarter of the mean value, at the same hour, on otherwise similar days before and after the eclipse. M. A. G.

1386. *Temperature Régime in Caverns.* **A. Roschkott.** (Meteorolog. Zeits. 38. pp. 33–38, Feb., 1921.)—A critical and historical account of contributions to the above subject. The problem to which attention was

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first devoted was the observed persistence of ice in some caverns, even during the period when the outside temperature is above freezing-point. Many theories were advanced only to prove untenable. Real progress was not made until Crammer transferred attention to the régime of air temperature in caverns in relation to the form of the cavern (the persistence of ice in some cases then following as a corollary) and an account is given of the main results of his work and of the later mathematical work of Bock. Caverns are of two main types—(1) having only one entrance, (2) having two or more extrances. Further subdivision of (1) is made according as the cavern (*a*) lies horizontally, (*b*) leads upwards, (*c*) leads downwards; and of (2), according as the entrances are (*a*) at the same level, (*b*) at different levels. Each type has its own characteristics, (1 *c*) being, for example, the "ice-pockets" owing to the ease with which cold air may penetrate them when temperature is lower outside, in constrast with the stability of the cold air within, when the air outside is warm. Little has been written on the subject in meteorological literature, and the author has drawn on other sources. It is pointed out, however, that caverns provide laboratories in which many meteorological problems may be studied, *e.g.*, eddy diffusion, in the absence of radiation complications. M. A. G.

1387. ***Radiation and Temperature of Snow and Convection of the Air at its Surface.*** **A. Ångström.** (Ark. f. Mat., Astron. och Fysik, 13. No. 21. [pp. 1–18] 1919.)—Observations of snow and air temperature and of radiation at Abisko (68° 21′ N., 18° 47′ E.) during the "arctic night," Jan. 1916, are utilised to evaluate the "convectivity" (k) of the air near the snow surface. The actual elements observed included (1) the effective radiation (R) by Ångström pyrgeometer exposed about 2 m. above the snow surface, (2) the temperature (t_2) of the air at this level, (3) the temperature (t_1) of the air 0·6 m. above the surface, (4) the snow surface temperature (t_0), (5) the snow temperature (t_s) 1·8 cm. below the surface. (1) is reduced to the effective radiation (R_0) of the snow surface by the relation

$$R_0/R = (273 + t_s)^4/(273 + t_2)^4,$$

the emissivity of snow for long waves being practically unity, while from t_0, t_1, and t_s are deduced the vertical temperature gradients at the surface, both in the snow and in the air. Now, considering the time of observation, direct and diffuse solar radiation are eliminated, while exchanges of heat due to condensation and evaporation at the surface are found to be of relatively small importance, and the temperature variations sufficiently slow to allow the surface to be treated as in temperature equilibrium. Accordingly $R_0 = k(\partial t/\partial h)_{\text{air}} - \lambda(\partial t/\partial h)_{\text{snow}}$. Selecting cases in which $(\partial t/\partial h)_{\text{snow}}$ is zero or small, an approximate average value of k is deduced from $R_0 = k(\partial t/\partial h)_{\text{air}}$ and this, when inserted in the previous formula, yields a value of $\lambda = 0{\cdot}00049$, in good agreement with the value 0·0005 deduced from Abel's formula $\lambda = 0{\cdot}0068\rho^2$ or the value 0·00059 from Jansson's formula $\lambda = 0{\cdot}00005 + 0{\cdot}0019\rho + 0{\cdot}006\rho^4$, where ρ is the density of the snow. Adopting this value of λ, and utilising all observations, the average value of k then becomes 1·8. These values of λ and k apply when R is measured in gm. cals. cm.$^{-2}$ min.$^{-1}$, and the thermal gradients in deg. C. cm.$^{-1}$. Individual values of k vary with the wind speed near the surface. In the cases considered, this averaged 2·8 m. sec.$^{-1}$ as measured by anemometer 15 m. above ground. M. A. G.

1388. *Forecasting Thunderstorms by Means of Static Electricity.* **F. W. Reichelderfer.** (Monthly Weather Rev. 49. pp. 152–153, March, 1921.) —During the summer of 1920, hourly observations of "strays" were made, 8 a.m. to 4 p.m. daily, at the Naval Air Station, Hampton Roads, Va., with a wireless set consisting of a six-step amplifier with variable condenser and head telephones. The antenna was a bi-directional compass coil and the choice of wave-length 600 to 2500 m. It was found that, on an average, the best results were obtained with wave-length 900 m. The average intensity of "strays" on days when no thunderstorms were reported near the station was 1·4 (scale 0 to 4) and on thunderstorm days 1·9. Direction was recorded and "strays" appeared most frequent in the N.W.–S.E. plane (probably to N.W.). In spite of these results, it is thought that observations of the kind, used in conjunction with the weather map and local meteorological data, will prove of use in thunderstorm forecasting for practical aviation purposes. A recording instrument for intensity is to be installed and one for direction is being devised.
M. A. G.

1389. *New Method of Constructing Average Monthly Rainfall Maps.* **M. de C. S. Salter.** (Roy. Meteorolog. Soc., J. 47. pp. 101–111; Disc., pp. 111–116, April, 1921.)—The method consists in combining the average monthly isomeric maps individually with a detailed isohyetal map showing average annual rainfall, thus producing average monthly isohyetal maps. For the construction of isomeric maps the average monthly rainfall for each station is expressed as percentage of the average annual rainfall of that station, and isomers are lines of equal percentage. It has been established that such maps are much less complex than isohyetal maps, being less dependent on orographical features, and can be drawn with relatively few stations, say 200 for the British Isles. Isohyetal maps, on the other hand, require at least 2000 stations, and are difficult to construct directly for monthly averages, owing to lack of knowledge of the relation of monthly rainfall to configuration, though this is fairly well known for annual totals and has been used in the construction of the detailed annual map. The indirect method has accordingly been utilised for the British Isles in a way fully described in the paper, which aims at bringing the method forward for discussion, and not at discussing the climatological results. A long discussion followed, the general opinion being that for the purpose in view the method is justified.
M. A. G.

1390. *Ocean Currents.* **R. O. Street.** (Roy. Soc., Proc. 99. pp. 39–46, April, 1921.)—*Dissipation of Energy.*—The dissipation of energy by non-turbulent flow having previously been considered [Abs. 1099 (1917)], the method is here extended to non-periodic motion. In all parts of the ocean there exist slow currents with constant direction whose velocities may be supposed to contain a component independent of time. The slowness of these currents makes it probable that the flow is non-turbulent, and on this assumption, the viscosity is found to cause a dissipation of energy in the non-periodic parts of ocean currents at the rate of 3×10^{18} ergs per sec.

Salinity and Velocity.—A simple method of deducing the magnitude of the surface current from a knowledge of the distribution either of the salinity or of the temperature is given. Estimates from the data available lead to concordant results.
W. A. R.

1391. *Age of the Earth's Crust.* **H. N. Russell.** (Roy. Soc., Proc. 99. pp. 84–86, April 6, 1921.)—It is pointed out that the considerations of radio-activity, which have been continually employed to determine the duration of geological time, can also be applied to assigning an upper limit to the age of the existing crust of the earth. Taking into account the lead ratio and the age of Pre-Cambrian minerals as determined by Barrell, the final figure of 4×10^9 years is arrived at as an approximation to the age of the crust. The radio-active data alone indicate that this estimate is very unlikely to be in error in either direction by a factor as great as three. Jeffreys estimated the age from the eccentricities of the present orbits of the planets, and found it to be 3×10^9 years—a result in close agreement with that here arrived at. W. A. R.

1392. *Theory of the Equatorial.* **W. Gyllenberg.** (Ark. f. Mat., Astron. och Fysik, Stockholm, 13. No. 19. pp. 1–41, 1919.)—After an introduction explaining why the equatorial cannot fulfil its original intention of direct measurement of accurate spherical coordinates, and hence must be confined to relative measurements from fundamental stars, the author proposes to correct for all possible instrumental errors by means of small rotations of rectangular axes. He deals with the different instrumental constants, and with the adjustments of an equatorial unprovided with circles, with the effect of instrumental errors on micrometric observations and on photographic plates, with special reference to those taken at or near the pole. Much stress is laid on the variable corrections for refraction and flexure, which depend on the altitude. W. W. B.

1393. *Flexure of Double-Telescopes.* **W. Gyllenberg.** (Ark. f. Mat. Astron. och Fysik, Stockholm, 15. No. 1. [pp. 1–14], 1920.)—This is an addendum to a previous paper [see preceding Abs.] dealing principally with the flexure of twin telescopes (guiding and photographic) such as the standard astrographic telescopes, in which the ordinary assumption of a flexure the same in all directions perpendicular to the optical axis is no longer applicable, as the double-telescope cannot be treated as a simple circular tube. W. W. B.

1394. *Comparison of Observed Clock Corrections at Sunset and Sunrise.* **R. H. Tucker.** (Lick Observat. Bull. 10 [Circ. No. 380] pp. 93–95, 1921.)—The result of comparison of sunset and sunrise clock errors at Lick Observatory in 1920 confirms the existence of a systematic difference, the effect being as if sunset transits were observed $0''\cdot06$ earlier, or as if the clock rate was slower in the daytime. Details are given of the method employed and the groups of stars used and the precautions taken to eliminate any such causes as magnitude equation or the effect of bright background. Various suggestions are made as to a possible cause of this systematic difference, including parallax, gravitational attraction of the sun on the pendulum, and horizontal refraction : but independent data from other observatories are expected to contribute to a solution. W. W. B.

1395. *Determinate Orbital Stability : its Mechanism and some of its Functions in Celestial Mechanics.* **F. B. Taylor.** (Am. J. Sci. 1. pp. 295–314, April, 1921.)—First calling attention to the three kinds of equilibrium, stable, unstable, and neutral, the author suggests similarly three kinds of stability for such a thing as the moon's motion round the earth. These he calls determinate or indeterminate stability and instability, where indeterminate stability corresponds to neutral equilibrium and instability to unstable equilibrium. Of these he considers the moon's orbit to be one of determinate stability, *i.e.*, that if the size of the orbit were to be increased it would tend to return to its present size. He discusses various changes in the relative distances of the three bodies and their gravitational effects on the system, for instance if the earth were as far away from the sun as Mars is, he says, the moon would have to be much nearer the earth for determinate stability. He explains in this way the nearness to Mars of its two satellites. He finds for each planet a satellite zone in the same way, stating that planets may acquire satellites by capture, but that these must come into its system within the orbit of its old satellites; thus if the earth picked up a new satellite it would come nearer than the moon and would have the effect of driving the moon further out just as an increase of the earth's mass would. In this connection he finds that Mercury cannot have a satellite at all and that Venus could hardly capture one. Also he finds in his calculations a real physical basis for Bode's law. He refers for further consideration of many planetary phenomena to his book on "The Planetary System." W. W. B.

1396. *Remarks on Secular Comets.* **G. Armellini.** (Accad. Lincei, Atti, 29. *ii*. pp. 183–186, Aug.–Sept., 1920.)—The author wishes to correct the view, often expressed, that when the orbit of a comet (corrected for planetary perturbations) turns out to be strictly parabolic, it should be considered as undoubtedly of stellar origin. He deduces from dynamical considerations the formula $R = (2T^2)^{1/3}$, where R is the max. distance from the sun (at aphelion), in astronomical units (semi-axis major of earth's orbit), and T is the time in years of describing a complete elliptical orbit. From values calculated by means of this formula it is shown that if a comet of strictly parabolic orbit is of stellar origin it will have for T a value of about 100 or 150 million years. The author proposes to call comets of this type *secular comets*, the ordinary comets of the planetary system being classed as periodic comets. The origin of the secular comets is most intimately connected with the motion of the sun in space. L. H. W.

1397. *Radiative Equilibrium in the Outer Layers of a Star: Temperature Distribution and Law of Darkening.* **E. A. Milne.** (Roy. Astron. Soc., M.N. 81. pp. 361–375, March, 1921.)—The author obtains an integral equation for the density of radiant energy in radiative equilibrium, and solves it by successive approximation. An arbitrary constant thus involved can be chosen in various ways to improve the accuracy of the solution. He finds that the density-gradient with respect to the optical thickness has a logarithmic infinity at the boundary, and obtains the boundary temperature approximately in terms of the effective temperature. The temperature distribution thus found he applies to deduce the law of darkening of a star disc towards the limb, for which Schwarzschild and Jeans have assigned a value $\frac{3}{5}$. The author considers his value of $\frac{2}{3}$ a better approximation to the truth: the distribution of intensity over the disc corresponds to a mean coefficient of about 0·61 or 0·62 with a more sudden drop in intensity very close to the limb. W. W. B.

1398. *A Physical Theory of Stellar Spectra.* **M. N. Saha.** (Roy. Soc., Proc. 99. pp. 135–153, May 2, 1921.)—The fact that the progression from one spectral class to another proceeds gradually and not by jumps induces the author to agree with H. N. Russell that the principal differences in stellar spectra arise in the main from variations in a single physical variable in the stellar atmosphere, and this variable he considers to be temperature. Increasing temperature has the effect of tearing off the outermost electron from the atomic system (called first-step ionisation). The author tabulates the stages of partial up to complete ionisation with increasing temperature for certain elements (Mg, Ca, Sr, Ba), and also for H, and He, and finds a spectroscopic test for the ionisation produced by a high temperature. Turning to the stars a similar tabulation shows the temperature at which various lines appear and disappear (*e.g.*, K, Mg 4481, 4686, the Balmer series, etc.). Finally he criticises some of Wilsing and Scheiner's values of class temperatures as being too low. Differences between "giant" and "dwarf" spectra show that the concentration of atoms has its effect as well as temperature, but on the whole he regards the stellar spectra as illustrating the gradual effect of an increase of temperature from 3000° K. to 40,000° K. W. W. B.

1399. *Clusters h and χ Persei.* **H. E. Macklin.** (Roy. Astron. Soc., M.N. 81. pp. 400–407, March, 1921.)—The author measured three plates taken at Oxford. He tested over 1700 stars for proper motion, finding an exceptionally small number of such proper motions, and these mostly in stars clearly unconnected with the clusters. He concludes that the clusters themselves have no appreciable movement, but hopes that a future determination, including fainter stars up to a total of 5500, will go far to settle this question. W. W. B.

1400. *Distribution of H and λ3727 in Orion Nebula.* **J. H. Reynolds.** (Roy. Astron. Soc., M.N. 81. pp. 410–411, March, 1921.)—By the use of screens of ultra-violet glass containing nickel oxide, on the 30-in. reflector of the Helwân observatory in Egypt, the author obtained dense images in the λ3727 radiation. These he compared with the results of other composite screens. A plate is given showing separately the H-image and the λ3727 image, and the author points out certain marked differences. On the whole his results agree with those of Hartmann, that the λ3727 radiation is mainly responsible for the outer extensions in unscreened photographs. W. W. B.

1401. *Photographic Light-Curve of Nova Cygni III.* **F. Henroteau.** (Roy. Astron. Soc. Canada, J. 15. pp. 155–158, April, 1921.)—From photographs taken at the Dominion observatory, curves are plotted corresponding to photographic and visual observations with an intermediate curve, called photo-visual, which was obtained with Cramer isochromatic plates, more sensitive to red and yellow than the Seed 30 plates with which the ordinary photographic curve was obtained. The photo-visual curve may not be quite accurate, as no yellow screen was used. There is an indication of a maximum occurring in a 12·6-day period, but much less marked than those of Nova Aquilæ III. W. W. B.

1402. *Spectrum of Nova Cygni III.* **W. E. Harper.** (Roy. Astron. Soc. Canada, J. 15. pp. 150–154, April, 1921.)—Nineteen plates were obtained on twelve nights from Aug. 24 to Sept. 28, 1920, at the Dominion observatory with the single-prism spectroscope on the 72-in. reflector. Sixteen of the photographs taken with Seed 30 plates have a range from λ3700 to λ5150, with dispersion at the centre of the plate of 25·7 Å. per mm. The other three, with shorter focus, on Ilford panchromatic plates, extend to λ6800 with smaller dispersion. A velocity of approach of 650 km. per sec., was indicated by H_β and enhanced Fe lines on Aug. 24, on which night the author asserts that emission was already shown. By the end of August the 650 km., if it is real, had increased to 1200 km. per sec. The emission lines were strongest at the red end, and grew rapidly fainter towards the violet. The emission bands are narrower than in Nova Aquilæ; Hα increased noticeably in width.

The main Nb bands, λ5007 and λ4959 are not shown in any of the plates, though shown in Nova Aquilæ ten days after maximum; two other Nb bands following before a month had elapsed.

The fine undisplaced H and K lines of Ca show a constant velocity equal to that of the solar system, thus indicating that the star, if the Ca belongs to it, is at rest. Fuller details are promised in a forthcoming publication of the observatory. W. W. B.

1403. *Nova Aquilæ III.* **F. G. Pease.** (Astron. Soc. Pacific Publ. 32. p. 334. Observatory, 44. p. 98, March, 1921.—Abstract.)—The planetary disc of Nova Aquilæ viewed in the 100-in. reflector, shows a bright bar crossing the disc in position angle 40°. This seems mainly due to the bright Nb lines at 5007 and 4959. In a slitless spectrogram the star appears S-shaped, the distortion being partly attributed to line-of-sight motion. W. W. B.

1404. *Spectra of Temporary Stars: Nova Ophiuchi,* 1919. **W. H. Wright.** (Lick Observat., Mem. 14. Pt. 1. pp. 1–26, 1920.)—This is the first of a series of papers intended to deal fully with spectra of individual novæ. Nova Ophiuchi was discovered by Miss Mackie in Sept. 1919, and the observations dealt with in the present paper were obtained between 1919 Oct. 30 and 1920 Aug. 11, with special attention to the dark-line spectrum near the maximum of Nov. 5, 1919. A general description of the spectrum, compared with that of Nova Geminorum II, is followed by detailed discussion of the bright-band spectrum and absorption spectrum, the table showing a striking correspondence with the α-Cygni spectrum. The second maximum referred to was accompanied by a marked increase in the strength of the continuous (dark-line) spectrum relatively to that of the emission bands. The emission spectrum consisted chiefly of radiations of H, and enhanced lines of Ca and Fe, with other unidentified bands observed in other novæ, and possibly some of the stronger lines of enhanced Ti. The dark-line spectrum was practically identical with that of Nova Geminorum II (1912) at maximum, closely resembling α Cygni, but stronger in Ti, weaker in Fe, with other points of difference. In both novæ lines of Sr, Ca, and Se were strengthened at maximum. The displacement of H and K is not the reflection of the solar motion, *i.e.*, the absorbing medium producing the lines is not at rest with respect to the visible universe. Six months after the November maximum, or 7½ months after the original maximum in Sept., the nova reached the nebular stage. Confirmation is found of the suggestion of Fowler and Baxandall that enhanced N is represented in the nova spectrum, and also some ordinary N-lines appear to be present. W. W. B.

1405. *Orbit of Spectroscopic Binary Boss* 5070. **W. E. Harper.** (Roy. Astron. Soc. Canada, J. 15, p. 147, April, 1921.)—This is a B3 star announced as a binary by Adams in 1912. The author obtained observations at Ottawa in 1915 and 1917, and at Victoria in 1920. The K line of Ca does not share in the large oscillations of the other lines, and indicates practically zero velocity when corrected for solar motion. Measures of H and He series, and of faint Si lines λ4567 and λ4552, a faint Mg line at λ4481, and occasionally a C line at λ4267, were obtained.

The period cones out at 12·427 days, the projection of the semi-axis major nearly 16 million km., and the mass-function 1·02 times the sun. W. W. B.

1406. *Spectroscopic Orbit of o Draconis.* **R. K. Young.** (Roy. Astron. Soc. Canada, J. 15. pp. 161–163, April, 1921.)—The binary character was announced at Lick Observatory in 1910. It is of class K, and so of a later type than most spectroscopic binaries of which orbits have been computed. The paucity of later-type orbits the author attributes to the small range of these objects when viewed with the ordinary single prism. Attention has therefore been paid to them with the 72-in. Dominion telescope at Victoria. Twelve spectrographs of o Draconis were taken in 1920, and from these, with two observations at Bonn in 1911 and five at Lick Observatory since 1902, provide material for drawing the radial velocity curve. The period comes out 138·420 days. W. W. B.

LIGHT.

1407. *Colour of Metallic Salts.* **Y. Shibata.** (Tokyo Chem. Soc., J. 40. pp. 463–482, 1919.)—From the spectrum analysis of compounds of Co, Ni, Cr the author concludes that the region of colour formation lies in these salts between the non-metallic atomic group and the metallic group, which form a nucleus for the complex ions or double salts. Colour is not developed by metallic salts without the formation of complex ions. Colourless inorganic salts showing strong absorption in the ultra or violet are composed of constituents which are absolutely transparent in this region. The wave-length of the light absorbed is the longer, the smaller the atomic volume of the metal in the centre of the complex. Experiments with salts of Zn, Cu, Cd, Hg, Pt, Ag support this theory, which is also applied to organic components. H. B.

1408. *Apparatus for the Microscopic Examination of Opaque Crystals.* **M. François.** (Comptes Rendus, 172. pp. 967–969, April 18, 1921.)—The apparatus consists of a very small concave mirror fixed concentrically with the end lens of the objective, a source of illumination in the optical axis of the microscope and below the stage, and an opaque spot below the crystal under examination. The radius of curvature of the mirror must be double the working distance of the objective, and therefore it is necessary to have a different mirror for each objective. J. L. H.

1409. *Orel-Zeiss Stereoscopic Camera for Photographic Surveying.* **W. Sander.** (Zeits. Instrumentenk. 41. pp. 1–27, Jan.; 33–60, Feb., and pp. 65–86, March, 1921.)—A very long and detailed description of the construction and method of use of the stereo-autograph. The paper is fully illustrated with diagrams of the apparatus, and concludes with a full bibliography of the subject. J. W. T. W.

1410. *A Monochromatic Illuminator of Special Design.* **F. C. Toy.** (Phot. J. 61. pp. 176–179; Disc., 179–181, April, 1921.)—The instrument here described is the outcome of an attempt to design an apparatus by means of which the following conditions could be fulfilled: (1) A section of a photographic plate could be uniformly illuminated either by one or two kinds of monochromatic radiation or by a mixture of both. (2) The intensities of the two different colours incident on the plate could be adjusted so that they were equal. (3) These intensities could then be varied in a known manner. The arrangement finally adopted is shown diagrammatically, as is also the construction of the double slit. The plate holder and its attached scale are arranged so as to be capable of movement along a slide in a direction parallel with the projected beam. A general photographic view of the instrument, complete with the exception of the plate holder, is given; its accuracy is not discussed here, except in so far as to state that a home-made apparatus will give relative values of the intensity with an accuracy estimated at about 1 %.

A. E. G.

1411. *Measurement of the Angles of the Prism of an Astrolabe.* **R. Baillaud.** (Bull. Astron. 1. No. 2. pp. 67–82, 1921.)—Describes measurements of the angles of the equilateral prism of the astrolabe of the Toulouse observatory. The method employed was that of double auto-collimation. A. W.

1412. *Constant-Deviation Prisms.* **G. Bruhat.** (J. de. Physique et le Radium, 2. pp. 115–118, April, 1921.)—In the case of the Pellin-Broca prism E. Bloch [Abs. 1022 (1919)] has suggested that it should be rotated about the point S, where the bisector of the right angle A meets the face BA′ at which the rays are internally reflected. The author of the present paper points out that this leads to a considerable lateral shift of the emergent beam and shows that much better results are obtained if the centre of rotation is taken at the middle point G of the face AB on which the incident beam falls. For a flint prism a rotation of 2° about S either way from the mean position, corresponding to the passage from one end of the visible spectrum to the other, gave a displacement of the emergent bean of 2 mm., while the displacements of the axes of the emergent and incident beams by rotation about G were only $2\,\mu$ and $33\,\mu$. A. W.

1413. *Dispersion of Hydrogen in the Ultra-Violet.* **M. Kirn.** (Ann. d. Physik, 64. 7. pp. 566–576, March 31, 1921.)—A determination of the absolute value of the refractive index of hydrogen for the green mercury line gave the result $(n - 1) \times 10^6 = 139{\cdot}65$, in which the fourth figure is regarded as certain. Measurements were made of the refractive index for many wave-lengths between λ5462 and λ1854. These results are tabulated, and two formulæ are given which represent the observations very closely. The measurements agree well with Koch's values, but extrapolation by Koch's formula for the shorter wave-lengths shows appreciable differences from the observed results. Comparison with the dispersion formula of Debye shows somewhat steeper slopes on the observed curve than on that calculated from Koch's and Cuthbertson's results. [See Abs. 1930 (1913).] A. W.

1414. *Electric Double-Refraction.* **S. Procopiu.** (Comptes Rendus, 172. pp. 1172–1175, May 9, 1921.)—It is known that liquids containing crystalline powders exhibit double-refraction in an electric field. The work here described was carried out with the object of finding whether any relation exists between the crystalline structure of the fragments and the double-refraction of the liquid. Results are given for a number of substances in toluene and benzene. It appears, from the discussion of the results, that the positive double-refraction observed in many cases is due to the crystals themselves, and the negative double-refraction is due to the arrangement of the particles in threads along the direction of the lines of force. The sign of the double-refraction is changed for those crystals for which the optic and electric dissymetry do not coincide. A. W.

1415. *Wide-Angle Astronomical Doublet.* **F. E. Ross.** (Eastman Kodak Co. Research Lab. Comm. No. 107. Optical Soc. of America, J. 5. pp. 123–130, March, 1921.)—Describes the characteristics of an astronomical doublet, and compares its performance with that of the Petzval portrait, the Taylor portrait, the Taylor Cooke, Zeiss Tessar, and Hawkeye lenses. None of these lenses gives really critical definition over more than about 5 to 8° half-angle. The new lens, however, is calculated to give critical definition over a half-angle of 14 to 15°. Over this area, correction for spherical aberration, coma, astigmatism, distortion, and colour is very nearly perfect. It works at an aperture ratio of 1/14.

J. W. T. W.

1416. *Orientation of Grains in Dried Photographic Emulsion.* **L. Silberstein.** (Eastman Kodak Co.'s Research Lab., Comm. No. 112. Optical Soc. of America, J. 5, pp. 171–177, March, 1921.)—If an emulsion, in which the (flat) grains are originally oriented equally in all directions, be allowed to dry and shrink in so doing, the grains will tend to flatten out and the number oriented between 0° and 45° to the horizontal will be greater than the number between 45° and the vertical direction. There are two possible laws which may be assumed to control the extent of the flattening as the shrinkage proceeds, but with a shrinkage to 10 % of the original bulk, the difference between the results obtained on these two assumptions is negligible. Actually it is found that in this case 94 % of the grains have their inclinations contained between 0° and 45°.

J. W. T. W.

1417. *Production of Black-Body Radiation Corresponding to High Temperatures.* **I. G. Priest.** (Optical Soc. of America, J. 5. pp. 178–183, March, 1921.)—Describes a method for obtaining light of a spectral distribution corresponding very closely with that given by a black body at high temperatures. The light from a gas-filled lamp is passed through three Nicol prisms and two quartz plates in series. The resulting light is shown to approximate quite closely to the theoretical distribution up to equivalent temperatures of about 4000° K. J. W. T. W.

1418. *Effect of Incorrect Angles in Reflecting Prisms.* **F. E. Wright.** (Optical Soc. of America, J. 5. pp. 193–204, March, 1921.)—Describes fully the different methods in use for determining the correctness and degree of error of the interfacial angles of reflecting prisms of various types, including the Dove erecting, the roof-edge, and the penta prisms. The paper contains curves which give the deviations of the rays transmitted by prisms in which the interfacial angles are in error by any given small amount. From these curves the sensitiveness of the several optical methods used for testing the accuracy of prism angles by the use of transmitted light rays, can be determined directly, and the suitability of each method thus expressed. J. W. T. W.

1419. *Isoplanatic Correction in Its Relation to the Sine Condition and Spherical Correction.* **E. Lihotsky** (Akad. Wiss. Wien, Ber. 128. No. 1. 1919) and **F. Staeble** (Bayer Akad., Sitzungsber. pp. 163–196, 1919). (Both abstracted together in Zeits. Instrumentenk. 41. pp. 60–62, Feb., 1921.)—The joint abstract gives an account of two methods of treating the problem and cannot be readily abstracted further. [See Abs. 1407 (1920).]

J. W. T. W.

1420. *Theory of Parallax Applied to Measurement in Photography.* **K. Zaar.** (Zeits. wiss. Phot. 20. pp. 168–182, Jan., 1921.)—Gives an out

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line of the theory of parallax as applied to the use of photography for the reconstruction or measurement in space of solid objects. The methods of photography (*a*) from the same position with lenses of different focal lengths and (*b*) from different positions with the same lens, are considered, and the application of the theory is illustrated by means of an example. J. W. T. W.

1421. *Resolving Power of Microscopes.* **A. W. Porter.** (Faraday Soc., Trans. 16. pp. 67–74, Sept., 1920.)—This paper gives a brief treatment of certain points relating to the resolving power and magnification of microscopes, with application to ultra-microscopy. Taking the case of two bright lines as the standard, it is shown that for a dry objective they must not be closer than half a wave-length for resolution under the best conditions of illumination. For an immersion objective with immersion medium of refractive index *n*, this should be divided by *n*. A. W.

1422. *The Microscope: Symposium and Discussion on Design, Construction, and Applications.* (Faraday Soc., Trans. 16. pp. 1–245, Sept., 1920.)—The papers contributed are for the most part summaries of present knowledge and do not lend themselves to abbreviation; those containing new matter or information of special interest are abstracted separately. After an introductory address by R. A. Hadfield the following general papers were read:—"Present Position and the Future of the Microscope," by **J. E. Barnard**; "Mechanical Design of Microscopes," by **F. J. Cheshire.** Then followed papers on *optics*, namely, "Notes on Microscopical Optics," by **A. E. Conrady** and "The Resolving Power of the Microscope," by **A. W. Porter** (see preceding Abs.) A group of papers on the *manufacture* of the microscope was next given, including "A Standard Microscope," by **C. Beck**; "Research in the Use of the Microscope," by **C. Beck**; "Progress in Microscopy from the Manufacturer's Point of View," by **F. W. Baker**; "A New Research Microscope," by **P. Swift.** A further group of papers dealt with the questions of *design and construction*, and include "Notes on the Future of the Microscope," by **E. Schneider**; "A New Microscope Illuminator," by **A. Silverman** (abstracted separately); "Some Problems in High-Power Photomicrography," by **R. E. Slade** and **G. I. Higson,** in which apparatus of great resolving power for use in the investigation of photographic emulsions is described; and "Fatigue Factor incidental in the Use of Optical Instruments," by **R. J. E. Hanson.** Then followed numerous papers on *applications in metallography, metallurgy, and engineering*, namely: "The Metallurgical Microscope," by **W. Rosenhain**; "Construction and Design of Metallurgical Microscopes," by **C. H. Desch**; "Notes on the Metallurgical Microscope," by **J. H. G. Monypenny** (abstracted separately); "Metallurgical Microscopes and their Development," by **L. Aitchison** and **F. Atkinson**; "Photomicrographs of Steel and Iron Sections at High Magnification," by **R. A. Hadfield** and **T. G. Elliott** (abstracted separately); "The High-Power Photomicrography of Metals," by **F. C. Thompson** [see next Abs.]; "Illumination in Micro-Metallography," by **H. M. Sayers**; "Improvements in Metallurgical Microscopes," by **A. Sauveur** (abstracted separately); "Sharpness in High Magnification Micrographs," by **C. Benedicks** and **E. Walldow** [see Abs. 1424 (1921)]; and six other short papers. Seven brief notes then followed on *Applications to metrology*, and two papers on the *testing of microscopes*. These are: "Testing of Microscope Objectives, etc., by Interferometry," by **F. Twyman** (in which an account is given of some objectives which have been tested by the methods previously described by the author), and "An Accurate Method of Objective and Substage Condenser Testing," by **H. Hartridge** (abstracted separately). A further ten contributions dealt with optical glass and miscellaneous applications, etc. L. H. W.

1423. *High-Power Photomicrography of Metals.* **F. C. Thompson.** (Faraday Soc., Trans. 16. pp. 162–165, Sept., 1920.)—1. *General.*—A discussion of the theory of resolution.

2. *The Davidson Super-microscope.*—The claims made for this instrument and a description of certain tests made on it are given. It is shown that the practical tests agree with theoretical considerations in demonstrating that the claims made are extravagant. J. L. H.

1424. *Sharpness in High-Magnification Micrographs.* **C. Benedicks** and **E. Walldow.** (Faraday Soc., Trans. 16. pp. 183–187, Sept., 1920.) —This paper describes some results with different types of illumination and illuminators obtained in an investigation of the new (le Chatelier type) Reichert microscope. It was found that: (*a*) A 350-c.p. arc lamp and a 50-c.p. glow-lamp gave exactly the same result. (*b*) A metal mirror gives slightly better results than a prism. (*c*) A le Chatelier prism and a 45° prism give, at high magnifications, exactly the same result, but at lower magnifications the le Chatelier prism has decided advantages. (*d*) At high magnifications, a plain glass illuminator gives better results than a prism. (*e*) In the plain glass illuminator, a thickness of 0·45 mm. does not sensibly injure the definition. J. L. H.

1425. *Focal Lines Formed by a Zone Plate.* **G. F. C. Searle.** (Cambridge Phil. Soc., Proc. 20. pp. 330–343, May, 1921.)—A theoretical treatment of the zone plate for oblique incidence of the light (*i.e.*, source away from the axis). In this case the plate gives rise to two focal lines and the positions of these are investigated. The theory is extended to the case in which any non-spherical wave-front falls upon a zone plate at any angle of incidence, and the corresponding positions and directions of the focal lines of the emergent wave-front are found. The paper concludes with a description of experimental results obtained in confirmation of the theoretical deductions. J. W. T. W.

1426. *Preparation of Non-spherical Surfaces in Optical Instruments.* **A. Gullstrand.** (Kgl. Svenska Vetenskapsakad., Handl. 60. 1. p. 155, 1919. Zeits. Instrumentenk. 41. pp. 123–125, April, 1921.)—Describes in abstract a mechanical method of obtaining definite non-spherical surfaces in glass. The apparatus consists of two parts—the first to grind to a definite radius of curvature, while the second ensures that this radius is applied to the correct part of the surface. The work was interrupted by the war, but a machine on this principle is now in course of construction. J. W. T. W.

1427. *Simplified Formulæ for Optical Calculation.* **M. Lange.** (Zeits. Instrumentenk. 41. pp. 121–123, April, 1921. Making use of the formula $1/v - 1/u = 1/f$ and multiplying by h, the distance of the incident ray from the axis of the lens, this formula becomes tan a_{v+1} — tan $a_v = h_v\phi_v$ where h/u = tan a and $\phi = 1/f$. Also $h_{v+1} = h_v - e_v$ tan a_{v+1}, where e is the separation. This method leads to a simple way of obtaining the formulæ for the calculation of a ray passing through an optical system.

J. W. T. W.

1428. *Photographic Plates for Extreme Ultra-Violet.* **J. Duclaux** and **P. Jeantet.** (J. de Physique et le Radium, 2. pp. 156–159, May, 1921.)—An attempt is first made to produce plates sensitive to the ultra-violet (as far as 1900 Å.) by the method adopted by Schumann, but afterwards it was found possible to attain the same end by different means. The distinguishing point of the Schumann plates is the small quantity of gelatine. A method is here described of treating ordinary plates of commerce so as to remove the excess of gelatine without interference with the silver salts. The thin emulsion layer which remains is very sensitive to extreme ultra-violet rays; *e.g.*, using a water-prism line 1854 Å. in the spectrum of aluminium is measurable in 1 second and line 1858 Å. in 5 secs., while an exposure of 10 secs. gives all the lines in the spectrum of iron as far as 1853 Å. A second means of obtaining the same result is by covering an ordinary plate with a layer of fluorescent matter upon the gelatine. This method, as here described, is a very simple one, giving regular results. It can be applied to any plates, in particular to orthochromatic plates, so that it is possible to have the complete spectrum from infra-red to ultra-violet on the same plate.

A. E. G.

1429. *Reduction of Radiographic Exposures. A New Type of X-Ray Plate.* **L. Levy, D. W. West,** and **T. T. Baker.** (Röntgen Soc., J. 17. pp. 55–63; Disc., 64–66, April, 1921.)—The speeds of all plates, produced by various manufacturers, are about the same. A trifling increase in speed of plates in general use might possibly be attained, but a considerable multiplication could not reasonably be expected. For these reasons it is thought best to consider the production of a plate upon entirely new lines, and the question of the combination of a plate and intensifying screen, all in one, soon presented itself as a possible solution. The new plate here described consists essentially of an X-ray plate, on the sensitive film of which is coated as a second layer a small quantity of calcium tungstate held in a suitable medium. Baker has recently developed an X-ray plate of the ordinary type which has proved particularly suitable for use in the production of the new type of plate; this X-ray plate is described in detail in the second part of this paper. The coated plate is exposed for a very short period, which may be anything from 1/20th to 1/30th of the normal exposure, and which varies with the nature of the object to be radiographed. Before development, the plate is placed in warm water for two or three minutes, when the top layer containing the calcium tungstate dissolves off. The final portions of this coating can, if necessary, be removed by rubbing with a pad of cotton-wool. Owing to the special nature of the light-sensitive emulsion the latter is entirely unaffected by this treatment, and the plate is then developed and fixed in the usual manner. The results obtained with this plate, may be briefly summarised as follows:—The effect photographically of the coating on the plate is two or three times as great as that of an intensifying screen. In the radiography of the thinner parts of the body, such as the foot and knee, the exposure is reduced to 1/25th of the normal exposure required with the X-ray plates at present in use. In the radiography of the thicker portions of the body, such as the chest and pelvis, the exposure is reduced to about 1/20th of the normal amount at present required. In contradistinction to all exposures made with an intensifying screen, the results obtained with the new plate are entirely free from graininess and are equal in this respect to the best results obtained with the present X-ray plates without a screen, which require twenty times the exposure. It is practically impossible to over-expose the new plate. Should it be accidentally given two or three times the necessary exposure, it is only necessary to reduce the time of development, when the resulting negative will be just as brilliant as if the correct exposure had been given. With regard to contrast in such a subject as the pelvic region and in regard to detail and brilliancy of the image the new plate compares very favourably with ordinary plates at present in use. Another advantage is the superior sharpness of outline obtained owing to the relative immobility of the patient during the very short exposure required. The possibility of taking a number of radiographs without the risks of burns and without the production of undesirable results is apparent. There is also a considerable reduction of wear and tear upon apparatus, especially upon tubes. The capacity of low-power installations is considerably increased. Results can now be obtained with a 12-in., and even with a 10-in. low-capacity coil set which were formerly possible only with far more expensive and powerful outfits. The great reduction of exposure will undoubtedly be of service in the X-ray examination of metals, etc. A kinematographic radiograph of the heart beating should be readily obtainable with ordinary apparatus. Double-coated films can be made on the same lines as the new plate, each light-sensitive emulsion being provided with its removable fluorescent layer. [See also preceding Abs.] A. E. G.

1430. *Damping of Radiation.* **G. Ribaud.** (J. de Physique et le Radium, 2. pp. 107–114, April, 1921.)—After indicating briefly the principles and the consequences of the electromagnetic theory of the damping of radiation, attention is drawn to the difficulties encountered in an experimental investigation of such damping. For such work it is absolutely essential to eliminate the effects of impacts, which modify the emission in a way as yet little known. In the attempts to measure the spectral widths of emission lines, the Doppler-effect of molecular agitation, much greater than the effect of radiation alone, has prevented any exact measurements. The measurements of Wien [Abs. 379 (1920)] are largely free from these sources of error, and the results confirm quantitatively the theory of Planck for the hydrogen line H_α. The agreement between the measurements of damping and the theoretical values for the other hydrogen lines and for the oxygen line λ4662 is not so good, but the observed and theoretical values are of the same order of magnitude. A. W.

1431. *Young's Interference Experiment.* **R. A. Houstoun.** (Nature, 107. p. 268, April 28, 1921.)—A simple method is described for performing the above experiment. A double slit is made by painting a piece of glass dead-black and then drawing two parallel scratches on it with the point of a knife, the scratches being about 0·6 mm. apart. The glass is then mounted on the table of a spectrometer. With this arrangement the bands can be easily observed, using a glow-lamp or a sodium flame, though they are not so bright as the bands produced with a biprism. With the above slit separation, the separation of the successive bands is about 3 minutes in the field of the telescope, and 10 or 12 bands can be counted. A. W.

1432. *The Photoelectric Theory of Vision.* **J. H. J. Poole.** (Phil. Mag. 41. pp. 347–357, March, 1921.)—It has been suggested that the light-sensation of the eye might be due to the action of photo-electrons excited by the incident light; it seems probable, anyway, that photoelectric action of some kind is involved in vision. The real point at issue is whether the photo-electron excited by the light ever gets free from its parent molecule, as occurs when a metal is illuminated by ultra-violet light, or whether the action may only disturb the equilibrium of the electron inside the molecule, thus altering the chemical properties of some light-sensitive compound in the eye. The latter view favours the Young-Helmholtz theory, but the former admits of a more simple and direct explanation of colour vision. In order to detect, if possible, photoelectric powers of the retina various experiments with the black pigment and rhodopsin removed from a freshly dissected bull's eye were made. Efforts were first made to ascertain whether such material acted as a sensitiser to a photographic plate. These experiments led to no direct evidence in favour of the photoelectric theory of vision, but in view of the difficulties involved it seems premature to suggest that the materials tested have no photoelectric effect. Next a direct method of testing the pigments was adopted, the material being placed on an insulated conducting plate and the rate of leak of negative electricity from the plate when illuminated tested by an electrometer. The apparatus is described by the authot in detail. The material was tested both moist and in a dry condition, but in no case was any photoelectric effect obtained. A test was also conducted on a freshly prepared retina from a frog's eye. This, while showing no permanent photoelectric effect, usually gave a very small effect for a few minutes after the retina was placed in the testing vessel. Such a very small current might be due to some extraneous effect. The conclusion is drawn that the photoelectric theory of vision is neither confirmed nor refuted by these experiments. J. S. D.

1433. *Rotatory Power in Biaxal Crystals.* **L. Longchambon.** (Comptes Rendus, 172. pp. 1187–1189, May 9, 1921.)—Difficulties encountered in the measurement of the rotatory power of biaxal crystals are first discussed. The special difficulty is that due to birefringence which arises from the luminous beam not being rigorously parallel to the optic axis of the crystal. An improved experimental arrangement is described by means of which it is possible to determine with considerable accuracy feeble rotatory powers, and results are given in a few cases. A. W.

1434. *Colour Antagonism or Chemical and Electrical Polarity of the Spectrum.* **G[abriele] Rabel.** (Zeits. wiss. Phot. 19. pp. 69–128, Oct., 1919.)—Observing that algæ growing in deep water, into which red rays could not penetrate, were not green but brown or red, Engelmann suggested (1883) that the light produced algæ, etc., of the complementary colour. The author growing algæ under coloured glasses found the colour of the plant to agree with the colour of the illumination, and she suggests that the two ends of the spectrum oppose one another in their photochemical and biological effects, and that red light destroys the effects of blue light; the latter rays of short length are the exciting rays, the red rays destructive or indifferent, rays from the middle portion of the spectrum may be either; the red light is termed positive, the blue negative. In discussing from this point of view chemical and electric, phototropic and biological effects and the photographic plate, and describing new experiments of her own, she points out that many modern observations of this kind are to be found in Ritter's "Galvanismus" of 1802. Phosphorescence is excited by negative light, destroyed by red light; colours are changed and restored by the different lights; silver salts are reduced and oxidised; potential changes are reversed; the retina behaves like an electrode; organisms are differently influenced. Experiments on the striations in discharge tubes (charged with hydrogen or water vapour) are described in detail. The electrodes are movable. When the kathode is pulled away from the anode, the whole column goes with it past the exploring electrode, new layers seeming to issue from the anode to fill the bared space; but the potential curves do not really admit of conclusions as to the distributions of the free charges. She therefore tried to find chemical evidence of the nature of the charge; plates covered with NaCl turned, in hydrogen, blue in the dark space, brown in the striæ, while in water vapour these colours were reversed; she failed to find any suitable reagent for positive charges. Apparently field potential and charge potential have to be distinguished in the striations. H. B.

1435. *Excitation Potential of the Spectral Lines of Mercury Vapour.* **J. Franck.** (Zeits. Elektrochem. 26. p. 305, Aug. 1, 1920. Paper read before the Bunsen Gesell., Halle, April, 1920.)—Sommerfeld has obtained a curve (based on Bohr's theory) showing the connection between the emission of spectral lines, and the quantum theory. A reproduction is given of a curve experimentally found for mercury vapour. This curve, connecting photoelectric current with the potential of the exciting electrons, shows a number of kinks, each of which corresponds to the excitation of one of the spectral lines of mercury. No attempt is made to assign these kinks to the proper spectrum lines. It may be found that this photoelectric method can be usefully employed as a spectroscopic method in regions where ordinary optical methods are not suitable. A. W.

1436. *Spectrum of Helium in Extreme Ultra-Violet; Improvement in Methods; New Line at* 585 Å.U. **H. Fricke** and **T. Lyman.** (Phil. Mag. 41. pp. 814–817, May, 1921.)—Reference is made to various earlier studies of the spectrum of helium in the Schumann region, and the statement is made that most of the lines observed in these early investigations [see Lyman, Abs. 778 (1916)] were due to impurities introduced into the helium by the strong disruptive discharge which was necessarily employed in the tube. The immediate cause of the present investigation was the discovery by several investigators of a resonance potential in helium corresponding to a wave-length of about 600 Å.U. [Horton and Davies (1919), Horton and Bailey (1920), Franck and Knipping, K. T.

Compton (1920)]. The improvements introduced were two in number: (1) by the use of a vacuum spectroscope with a grating of but 20 cm. radius the gas absorption was greatly reduced; and (2) by the use of direct current on the discharge tube the chance of impurities was minimised.

The result of these improvements was the discovery of a *fairly strong line at* 585 Å.U. The existence of this radiation was confirmed by an observation with a vacuum grating spectroscope of 97 cm. radius.

It is interesting to note that the resonance potential corresponding to 585 Å.U., 21·2 volts, agrees rather with the results of Franck and Knipping than with those of other investigators.

Other lines usually present on the plates are 686, 860, 972, 992, 1026, and 1176—these all show varying intensities and none of them occur on all the plates. Their behaviour indicates that they are due to impurities. The strongest line on all the plates is 588 and its intensity bears a constant ratio to the direct image of the slit. A. B. W.

1437. *Pole-Effect in the Arc Spectrum of Manganese.* **S[ophie] Brendel-Wirminghaus.** (Zeits. wiss. Phot. 20. pp. 229–256, May, 1921.)—The object of the research described was to investigate whether the lines in the arc spectrum of manganese show the pole-effect and whether their wave-lengths exhibit variations with different current strengths. Measurements were made of many lines in the ultra-violet and in the green-yellow regions of the spectrum, and the results obtained show no perceptible wave-length changes under the different conditions. The pole-effect must consequently be regarded as absent in the case of manganese. A certain number of calcium lines occurred in the spectrum, and measurements of these also gave negative results as regards wave-length changes. A. W.

1438. *Balmer's and Deslandres' Terms.* **A. Sommerfeld.** (Ark. f. Mat., Astron. och Fysik, Stockholm, 15. 8. pp. 1–5, 1921.)—Certain assumptions relative to the moment of inertia of the rotating electron in Bohr's model atom lead to simple derivations of expressions for Balmer's and Deslandres' terms. It appears that the Deslandres' term plays the same part in relation to band spectra as Balmer's term does for series spectra. [See Abs. 893 (1919).] A. W.

1439. *Absorption Spectra of Chlorine for X-Rays.* **A. E. Lindh.** (Comptes Rendus, 172. pp. 1175–1176, May 9, 1921.)—Experiments were carried out with C, LiCl, NaCl, KCl, $KClO_3$, $KClO_4$, $ThCl_4(H_4N_2)$, $SnCl_6[Cr(H_2O_4)Cl_2]Cl$. For gaseous chlorine and for those compounds in which the chlorine has a valency of 1, no difference could be observed between the wave-length of the limit of absorption and that of chlorine in the combination NaCl determined by Fricke [Abs. 1604 (1920)]. On the other hand, the absorption spectra of chlorine of valencies 5 and 7 in the combinations $KClO_3$ and $KClO_4$ show a displacement of the limit of absorption towards the shorter wave-lengths. This displacement amounts to about 0·006 Å. for chlorine of valency 5 and to about 0·012 Å. for valency 7. [See Abs. 875 (1921).] A. W.

1440. *Emission Band Spectrum of Iodine.* **W. Steubing.** (Ann. d. Physik, 64. 8. pp. 673–692, April 29, 1921.)—This paper describes research carried out to obtain further knowledge concerning the iodine molecule and the emission of its band spectrum. A brief resumé is given of the phenomena observed with iodine vapour, and then details are given of experiments concerning the fluorescence of iodine vapour, its behaviour in the ionised state, and the effect of both longitudinal and transverse magnetic fields. Many results can be explained if it is assumed that the iodine molecule, besides the ionised and the completely neutral conditions, can also exist for a time in an intermediate state; and during this time of transition, which is estimated to be about 5×10^{-8} sec., it emits the band spectrum. [See Abs. 897 and 596 (1919).] A. W.

1441. *Spectra of Gold and Platinum in the Extreme Ultra-Violet* (λ1843–λ1461). **L.** and **E. Bloch.** (Comptes Rendus, 172. pp. 962–964, April 18, 1921.)—Handke has measured the spark lines of gold as far as λ1623·2. The authors have extended the wave-length measurements to λ1400. A table is given of 109 lines from λ1850 to λ1400, the first 10 of which are not trustworthy, and the last 14 were calculated by extrapolation and may present systematic errors. In the region dealt with by Handke most of the intense lines given by him were observed and measured. The spectrum of platinum in the Schumann region is here given for the first time. The table includes 151 lines between λ1843 and λ1461. A. W.

1442. *Luminescence at High Temperatures.* **E. L. Nichols** and **D. T. Wilber.** (Nat. Acad. Sci., Proc. 6. pp. 693–695, Dec., 1920.)—Luminescence has been discovered at temperatures above those at which ordinary phosphorescence disappears, and fluorescence, excited by light, reaches extinction. The glow is produced by a new type of excitation, *i.e.*, by contact with the outer zone of the hydrogen flame; also in some instances by kathode bombardment and the action of X-rays. The effect is quite distinct from photo-luminescence, from which it differs in many respects. The effect often occurs at temperatures far below the red heat. When superimposed upon the red heat it is readily distinguishable (*a*) by its colour, which is more often green, blue, or white than ruddy; (*b*) by its law of decay, which is that of vanishing phosphorescence and not the law of cooling; (*c*) by its spectrum, which is a characteristic broad-banded fluorescence spectrum, often lacking altogether in the red. The bands of these spectra are made up of overlapping components which form series with the usual uniform frequency intervals. The upper limiting temperature differs with various substances, varying from 52° C. for aluminium oxide to 940° C. for zinc oxide and pure zinc sulphide. Fuller details will be given in later papers. A. W.

1443. *Scattering and Absorption of Hard X-Rays in the Lightest Elements.* **T. E. Aurén.** (Nobelinst., Meddel. 4. 5. Phil. Mag. 41. pp. 733–743, May, 1921.)—By means of a compensation method in adjusting the thickness of a water layer so that its absorption for a pencil of X-rays is equal to that of a liquid layer 1 cm. thick, the author has made determinations of the relative atomic absorption coefficients of a number of elements [see Abs. 439 (1919)]. As the influence of the effect of scattering in the lightest elements is so great compared with true absorption that it cannot be neglected, it was supposed that deviations from the constant relation of the absorption coefficients in different wave-lengths was entirely due to this effect. A careful determination is now made of the absorption and scattering coefficients of hydrogen, nitrogen, oxygen, and carbon. These quantities are deduced from observations of the absorption coefficients of a number of organic liquids containing these elements. In the following table values are given (at different wave-lengths) for the atomic absorption coefficients of H, C, N, and O in relation to the molecular absorption coefficient of H_2O:—

$10^8 \times \lambda$.	0·359.	0·302.	0·264.	0·237.	0·215.	0·194.
k_{H/H_2O}	0·068	0·081	0·088	0·093	0·096	0·098
k_{C/H_2O}	0·504	0·532	0·547	0·560	0·572	0·575
k_{N/H_2O}	0·663	0·675	0·674	0·683	0·684	0·685
k_{O/H_2O}	0·874	0·838	0·824	0·814	0·808	0·804

With regard to the scattering coefficients the author finds the following relation to fit his observations: $s/\rho\,.\,a = Z_a/M_a\,.\,0\cdot387$, where s/ρ is the mass-scattering-coefficient, M_a the atomic weight of the element (a), and Z_a its atomic number. For hydrogen, $s/\rho = 0\cdot387$, agreeing closely with the value found by Barkla. The constant 0·387, however, is deduced from values which are dependent on the wave-length λ.

A. B. W.

RADIO-ACTIVITY.

1444. *The Range and the Life of* α-Rays. **F. Kirchhof.** (Zeits. phys. Chem. 93. pp. 619–622, Sept. 26, 1919.)—Plotting the logarithms of the ranges and lives of α-rays from U, Ra, Th, Ac, the author finds that, as the range decreases, the life increases, not growing to infinity, but to a life limit of 10^{15} or 10^{18} years. Each family gives its own type of curves, but the shorter the life, the greater the energy with which the α particles are ejected: there is no simple relation, however. Life and range of isotopes depend partly upon the family to which they belong. All elements probably have a life limit, possibly of the order indicated.

H. B.

1445. *Disintegration of Elements by α-Particles; Range of "H" Particles.* **E. Rutherford, J. Chadwick.** (Nature, 107. p. 41, March 10, 1921.)—Using improved optical conditions for counting weak "H" scintillations, the authors have discovered that the range of the "H" particles emitted from nitrogen atoms when bombarded by RaC α-particles is about 1·4 times as great as the corresponding range of "H" atoms from hydrogen. Definite evidence has also been obtained of the existence of long-range (> 32 cm.) particles from boron, fluorine, sodium, aluminium, and phosphorus. The range of particles liberated from lithium, beryllium, carbon, oxygen, magnesium, silicon, sulphur, chlorine, potassium, calcium, titanium, manganese, iron, copper, tin, and gold is probably *less* than 32 cm. In the case of Al the range of the particles is surprisingly great, and certainly not less than 80 cm.

It is suggested as probable that these long-range particles are in reality "H" atoms liberated at different speeds from the elements. It is of interest to note that no effect is observed in "pure" elements the atomic mass of which is given by $4n$, where n is a whole number. The effect is, however, marked in many of the elements the mass of which is given by $4n + 2$ or $4n + 3$. Such a result is to be anticipated if atoms of the $4n$ type are built up of stable helium nuclei and those of the $4n + a$ type of helium and hydrogen nuclei. No particles have so far been observed for any element of mass greater than 31; this may indicate a sudden change of nucleus structure at this point. A. B. W.

1446. *Wave-length of Hard γ-Rays.* **A. H. Compton.** (Phil. Mag. 41. pp. 770–777, May, 1921.)—Rutherford and Andrade [Abs. 185 (1915)] have determined the wave-length of certain hard γ-rays from RaC, using a method of reflection from a crystal of rock-salt. In their experiments spectrum lines were observed at angles as small as 44 minutes, corresponding to a wave-length of about 0·07 Å.U. The very penetrating radiation from RaC has, however, a much shorter wave-length, various lines of theoretical reasoning suggesting components lying between 0·01 and 0·04 Å.U.

New Method of Measuring the Wave-length of h.f. Radiation.—In the present paper a new method of measuring the wave-length of high-frequency radiation is proposed, and is applied to determine the wave-length of these very hard γ-rays. Instead of studying the spectrum lines reflected by a grating composed of regularly arranged atoms in a crystal, the author proposes to observe the diffraction pattern due to the individual atoms. This involves a knowledge of the effective diameter of the atom, which the author determines by certain measurements with X-rays of known wave-length. The principle of the method resolves itself into a determination of the angle at which γ-rays are scattered from lead and copper in the same ratio as the X-rays were scattered at 90° in Barkla and Dunlop's experiments [Abs. 685 (1916)]. The author determines these angles experimentally, and from them deduces that the wave-length of the hard γ-rays from RaC lies between the values 0·025 and 0·030 Å.U. A. B. W.

1447. *Degradation of γ-Ray Energy.* **A. H. Compton.** (Phil. Mag. 41. pp. 749–769, May, 1921.)—The principal experimental results of this paper are summarised by the author as follows:—

"By far the greater part of the secondary γ-radiation from matter traversed by the hard γ-rays from RaC is fluorescent in nature. If any truly scattered radiation is present, at 45° it probably amounts to less than 15 %, and for angles greater than 90° is less than 3 % of the secondary rays.

"At large angles with the primary beam the scattered energy is probably less than 0·001 of that required by the usual electron theory. The secondary fluorescent radiation is found, in accord with observations by others on the whole secondary radiation, to be harder and more intense at small angles with the incident beam than at large angles, and tables are given showing the manner of this variation. While at large angles the radiation from heavy elements is somewhat more penetrating than that from the light elements, at small angles both the hardness and the intensity of the fluorescent radiation are approximately the same from elements covering a wide range of atomic numbers. A study of the absorption coefficients of this radiation in various elements shows that the softest parts of it, though of shorter wave-length than the *k*-radiation from lead, are not harder than the most penetrating X-rays. The hardest parts approach in penetrating power the primary γ-rays from RaC.

"It is pointed out that the very small scattering observed is not incompatible with the classical electrodynamics, if the wave-length of the γ-rays and the diameter of the electron are of the same order of magnitude. A satisfactory explanation of the observed fluorescent radiation is found in the γ-rays produced by the impact of the secondary β-particles liberated in the radiator by the primary γ-rays. The observed asymmetry in the intensity and hardness may be accounted for if the oscillators which give rise to the fluorescent radiation are electrons moving in the direction of the primary beam with about half the speed of light. The wave-length of the softest part of the observed fluorescent radiation is shown to lie between 0·06 and 0·12 Å.U., probably nearer the former value, while the wave-length of the hardest part is probably about half as great. By a comparison of absorption coefficients, the effective wave-length of the hard γ-rays from radium is estimated at about 2 or 3×10^{-10} cm."

A. B. W.

HEAT.

1448. *On the Latent Heats of Vaporisation.* **E. K. Rideal.** (Cambridge Phil. Soc., Proc. 20. pp. 291–298, May, 1921.)—No relationship has been discovered between the infra-red vibration frequencies of the elements and their latent heats of vaporisation. If the assumption is made, however, that inter-molecular, chemical, and physical actions take place with energy-transfer in quanta, latent heats of evaporation may be derived from some natural vibration frequency or spectral line, not necessarily in the infra-red. The heat of evaporation per gm.-molecule may be taken as $L = Nh(\nu_{\text{products}} - \nu_{\text{reactants}})$, h being Planck's constant, ν_p and ν_r the vibration frequencies of the products (the metal vapour), and the reactants (the solid or liquid evaporating) respectively. Calculations are given, and show in many cases close agreement with observed values of the latent heat. The choice of the particular fundamental line is somewhat arbitrary, and an alternative method is given, based on the assumption that the activation of a metal atom can be assumed to take place in two distinct steps—the activation of the positive nucleus, and the activation of the valence electron attached to it. These frequencies are given by the $\nu_{\text{infra-red}}$ and $\nu_{\text{ultra-violet}}$ respectively, while the activation frequency of the atom as a nucleus-electron complex corresponds to the "radiation potential" of the element. The latent heat is then given by $L = \frac{1}{2}Nh\left\{\nu_{\text{radiation}} - (\nu_{\text{infra-red}} + \nu_{\text{ultra-violet}})\right\}$. There is sufficiently good agreement to indicate the validity of the quantum relationship in this physical molecular energy interchange. Extensions of the hypothesis, involving new assumptions, are treated mathematically, and interesting results obtained. T. B.

1449. *Thermal Dilatation of Solid Paraffins and of their Solutions.* **W. v. Piotrowski.** (Zeits. phys. Chem. 93. pp. 596–606, Sept. 26, 1919.)—Ordinary paraffins, being mixtures, have no real definite melting-points. The author's experiments were made in the Drohobycz oilworks; the crude paraffins were refined (partly by rapid vacuum distillations), the solvents (only described as a heavy benzene, blue oil, etc.) were not refined. Nine paraffins melting between 50·5° and 64·0° gave expansion coefficients varying from 0·000842 to 0·005108; the average was restricted to the limits 0·001114 and 0·003492. These figures agree fairly well with those which Zietkowski (dissertation, Freiburg, 1900) observed for paraffins from lignite tars. The coefficients of the liquid tar paraffins were about twice as large, however, as those of the solids. Near the melting-points the densities become irregular; above the melting-point density can approximately be deduced from the rule of mixtures. For solvents of higher density than the paraffin, the relation between the density and temperature is given by an equation of the first degree. H. B.

1450. *Vapour Tension and Molecular Constitution of Liquid Argon and Mixtures of Argon with Nitrogen. Theory of Binary Mixtures.* V. **F. Dolezalek.** (Zeits. phys. Chem. 93. pp. 585–595, Sept. 26, 1919.)—

Analysing the experimental data of Holst and Hamburger [Abs. 217 (1916)] the author finds that liquid argon is capable of affinity, and forms partly molecules of two atoms, the association constant being 0·20 at 85·11° K. There would hence not be any fundamental, but only a gradual difference between the so-called noble gases and other gases. When argon is diluted with nitrogen, both liquid, the diatomic molecules dissociate in accordance with the mass law. The vapour tensions of such mixtures and the constitutions of the gas mixtures can be calculated by the laws of the solution-theory of the author and others, which Holst and Hamburger have thus confirmed. H. B.

1451. *Some Properties of Steam.* **M. Jakob.** (Zeits. Vereines deutsch. Ing. 65. pp. 568–570, May 28, 1921.)—In a review of Callendar's "Properties of Steam and Thermodynamic Theory of Turbines" in *Engineering* [see Abs. 1103 (1921)] the work of German technical thermodynamical investigators is criticised. Allegations are made of the neglect of the work of Kelvin and Callendar, and of the inaccuracy of German tables dealing with the properties of steam, and it is further stated that the only accurate tables are those based on Callendar's formula.

Callendar bases his method of deriving the expression for the specific volume v from the well-known equation of state: $v - b = RT/p - C$. In Germany also simple equations of state have been obtained, for example that of Steinwehr (Zeits. f. Physik, 3. p. 466) depending on Nernst's assumption that steam consists of simple and complex molecules, both of which obey the gaseous laws. A state of equilibrium which varies with the temperature exists between the two kinds of molecules, and the corresponding equation of state is $Pv = RT(1 + \alpha)$, where α denotes the fraction of the gas dissociated. Steinwehr calculates α with the help of values of the saturation volumes determined by Holborn, and obtains an expression for the specific volume v, from which a few values are calculated and found to agree with those of Callendar. The author has previously pointed out that the equation $\delta c_p/\delta p = -1/J\,.\,T\,.\,\delta^2 v/\delta T^2$ gives a very sharp criterion for the exactness of an equation of state. Making use of it, he derives from Steinwehr's equation an expression for c_p. Callendar's equation treated similarly gives values for c_p which agree with these. The fact that all known equations of state for steam which are based on values of v give very inaccurate values for c_p has induced the author to recommend the reverse procedure, namely, to start with an empirical formula for c_p and deduce v. An expression obtained by Eichelburg for c_p gives values in very close agreement with the latest values obtained by the Munich physicists, and values for v are deduced from it. These equations are then compared with Callendar's equation, and the results discussed. *Engineering* appears to have been misinformed as to the critical temperature of steam, which was found by German physicists to be 374° C.

T. B.

ELECTRICITY AND MAGNETISM.

THEORY, ELECTROSTATIC AND ATMOSPHERIC ELECTRICITY.

1452. *Electric Field of the Atmosphere during the Solar Eclipse, April* 8, 1921. **J. Rouch.** (Comptes Rendus, 172. pp. 925–927, April 11, 1921.)—Observing at Brest, where the eclipse lasted from 8h. 24m. to 10h. 55m. (summer time) with maximum at 9h. 40m., it was found that just before the commencement the potential gradient exceeded 200 volts/m., and was very variable. From 8h. 24m. to 10h. 20m. it remained variable with a mean exceeding 250 volts/m., probably somewhat higher than before the eclipse. Then followed a steadier period with a progressive decrease to a minimum of 20 volts/m. at 10h. 50m., after which it increased, again passing 250 volts/m., at 11h. 8m. This high value was maintained until observations were discontinued at 11h. 30m. Throughout, the sky remained clear and the wind constant. Such a decrease in potential gradient, about 42 minutes after maximum eclipse, was observed by Le Cadet during the total eclipse of Aug. 30, 1905, but all previous results are not in agreement. M. A. G.

DISCHARGE AND OSCILLATIONS.

1453. *Mobility of Gaseous Ions.* **J. Cabrera Felipe.** (R. Acad. Ciencias, Madrid, 17. pp. 64–107, 1920. J. de Physique et le Radium, 2. p. 17d., Jan., 1921.)—Using the Rutherford a.c. field method as modified by Franck and Lattey, the author obtains values for the mobility in air at 20° C. which are practically identical with Rutherford's early ones—namely: V_+, 1·49 cm./sec.; V_-, 1·89 cm./sec. For the positive ions, V is a linear function of X/p, up to $p = 24$ mm. and $X/p = 0{\cdot}5$; for the negative ions the same holds up to values of $p = 50$ mm., and $X/p = 0{\cdot}5$ respectively. At lower pressures the law expressing the behaviour is more complicated. L. H. W.

1454. *Electric Discharge in Hydrogen.* **D. N. Mallik.** (Phil. Mag. 41. pp. 304–307, Feb., 1921.)—It is well known that the electric discharge in hydrogen is, for some obscure reason, somewhat erratic. Wilson and Martyn found that the rotation effect in a De La Rive's tube was not at all well marked. The present author was unable to detect any rotation of the discharge at all in a tube which had given good results with other gases. The experiments were repeated with tubes of various lengths and using different e.m.f.'s, and it was found that the rotation is observable in hydrogen as in other gases but that the conditions have to be carefully adjusted. The present paper gives a theoretical discussion, which is necessarily incomplete owing to our ignorance of the intricate mechanism of the discharge. It is found that the effective voltage of the induction coil producing the discharge at the rotation stage must vary inversely as the density of the gas used. Therefore, in the case of hydrogen, the effective voltage required will be much higher than in the case of air and accordingly the effect will be much more difficult to observe. T. H.

1455. *Theory of the Vacuum Discharge.* **G. Jaffé.** (Ann. d. Physik, 64. 8. pp. 733–744, April 29, 1921.)—The previous theory of the high-vacuum discharge is, through consideration of the length of the paths of electrons, further developed on the side of higher pressures. The current-voltage characteristics which it gives are very similar to the earlier formulæ, but the pressure dependence is now different. By consideration of the thermic velocity at the limit of the region of validity a stronger increase of the current density with the voltage is to be expected. From the given calculations there is a possibility of removing the want of accord between the researches of Lilienfeld and the theory of the author. **J. E. Lilienfeld.** (Ann. d. Physik, 64. 8. pp. 745–749, April 29, 1921.)—Lilienfeld criticises Jaffé's theory. A. E. G.

1456. *New Method of Exciting Undamped Electromagnetic Waves based on Deflection of Kathode Rays for Interruption Purposes.* **A. Nasarischwily.** (Ann. d. Physik, 64. 8. pp. 759–760, April 29, 1921.)—Describes a kathode-ray tube of a type due to Samson [Abs. 983 (1918)] in which the kathode stream is rapidly made and broken by an external Neef interruptor; the making or breaking of the kathode stream causes the production of undamped wave energy in the secondary of a transformer the primary of which is connected to electrodes fixed transversely to the kathode stream, or to an inductance producing a magnetic field; *i.e.*, the so-called Braun kathode tube is utilised to produce undamped oscillations. B. J. L.

1457. *Dissociation of Hydrogen and Nitrogen by Electron Impacts.* **A. L. Hughes.** (Phil. Mag. 41. pp. 778–798, May, 1921.)—An investigation was made of the disappearance of hydrogen and nitrogen at low pressures when an electron stream is passed through them. For hydrogen, no disappearance was obtained unless the electrons had energy above 13 volts. The rate of disappearance rose rapidly as the energy of the electron was increased to about 70 volts, after which no rapid change was noted; the rate appeared to diminish somewhat when the energy of the electrons was raised from 150 to 300 volts. For nitrogen, the rate of disappearance was at first much less than for hydrogen, but when the energy of the electrons was raised sufficiently (roughly 200 volts) the rate of disappearance of the nitrogen exceeded that for hydrogen. Reasons are given for thinking that this disappearance is due to the splitting-up of the molecules into atoms when electrons collide with the molecules, and that these atoms condense on the adjacent surfaces, particularly if they are cold. The max. rate of disappearance of hydrogen occurred when electrons of energy corresponding to 140 volts were used. About one molecule disappeared for every six collisions. Langmuir's work on the thermal dissociation of hydrogen showed that the clean-up, even under the most favourable circumstances, accounted for only 1/7 of the amount of dissociation. Hence it is possible that when the electrons have the right amount of energy a dissociation may occur almost at every collision.

A *peculiar clean-up*, apparently due to absorption of nitrogen by a Pt filament covered with BaO and SrO, when cooled to the temperature of liquid air, was observed during the course of the experiments.

A. W.

1458. *The Kathode Fall.* I. *In Neon and Helium.* **H. E. Watson** and **G. R. Paranjpé.** (Indian Inst. of Sci., J. 2. pp. 143–165, Nov., 1918.)—An investigation by Aston's method [Abs. 659 (1911)], throwing a beam of kathode rays transversely through the discharge and measuring the deflection of these rays. The electrodes were parallel plane plates of various metals, taken from different groups, as wide as the cylindrical discharge tube. The kathode fall was found to be 145·5 volts for neon and 155·5 volts for helium, being constant within 5 % for the same gas with all the 24 metals tried. It is not suggested that the figures should be constant. Gas pressure and current were varied; the results agreed with observations made by others with the aid of exploring wires.

II. *In Argon, Hydrogen, and Nitrogen.* **G. R. Paranjpé.** (*Ibid.*, 2. pp. 166–177, Nov., 1918.)—The values observed in case of each gas were nearly the same for all the kathode metals used. Nitrogen behaved like a monatomic gas, hydrogen showed irregularities ascribed to secondary effects. H. B.

1459. *Disappearance of Gas in the Electric Discharge.* II. **Research Staff of the General Electric Co., London.** (Phil. Mag. 41. pp. 685–706, May, 1921.)—A continuation of previous work [Abs. 510 (1921)]. Some of the minor conclusions of the earlier paper were found to be erroneous. The present paper discusses the disappearance under the electric discharge of hydrogen, carbon monoxide, nitrogen, and argon, both in the absence and presence of phosphorus vapour. In the presence of incandescent tungsten, *hydrogen* disappears without the passage of the discharge, as discovered by Langmuir [Abs. 523 (1913)]. The gas disappearing adheres without change to the surface of the glass, especially the cooler parts of it. When the discharge passes, the rate of disappearance is not greatly altered; but the phenomenon is greatly complicated by the simultaneous liberation of absorbed gas by bombardment, and by the appearance of water-vapour. The gas that has disappeared is again adhering to the glass walls either as hydrogen or as water. In the discharge, *carbon monoxide* is converted into dioxide; the dioxide, as well as the original monoxide, adheres to the glass walls and can be liberated thence by heating. The quantity of CO_2 which will adhere to the glass is very much greater than the quantity of hydrogen which will so adhere. *Nitrogen* disappears under the discharge, but cannot be liberated again by baking the evacuated vessel. At the same time the filament wastes and the walls are blackened. It is probable that Langmuir's nitride WN_2 is formed, but it is thought that part of the gas is held to the walls in its original form by a covering layer of tungsten. *Argon* disappears like nitrogen with much blackening of the bulb; but the gas can be restored by baking, together with hydrogen produced by the bombardment of the glass. *Mercury* has not been proved to disappear. The discharge through the vapour liberates large quantities of gas from the glass, even if it has been previously baked in a high vacuum.

Action of Phosphorus.—Phosphorus vapour disappears rapidly in the discharge, being converted into red phosphorus, which is deposited on the walls. The glow potential of phosphorus vapour is anomalous. Hydrogen, CO, and nitrogen when mixed with phosphorus vapour disappear in the discharge, together with phosphorus. A lower final pressure can be reached with a given applied potential in the presence of phosphorus than in its absence. This fact is correlated with the abnormal glow poten-

tial of phosphorus vapour. Evidence is adduced against the view that the action of phosphorus in removing gases in the discharge is a chemical one. The state of these gases when they have disappeared in the presence of phosphorus seems not to differ from the corresponding state in the absence of phosphorus. There is no indication of a law of constant proportions. The state of the glass walls modifies profoundly the absorption of gas. An alternative theory of the effect of phosphorus is proposed. It is suggested that the deposited red phosphorus covers the deposited gas and prevents it from being liberated again by bombardment. At the same time it provides a new surface on which gas can be adsorbed.
A. W.

1460. *Electrodeless Discharge in Sodium Vapour.* **J. K. Robertson.** (Nature, 107. p. 269, April 28, 1921.)—By placing a primary Tesla coil about a highly exhausted pyrex bulb containing metallic sodium, and enclosing the whole in an oven, a brilliant electrodeless discharge was obtained at a temperature of about 300° C. A preliminary examination of the spectrum revealed a number of sodium arc lines. After 2 or 3 hours' continuous heating the discharge was almost as brilliant as initially, though the bulb had the usual brown colour. A further study is being made of sodium and other metallic vapours, and for this more powerful excitation will be used. A. W.

1461. *Electromagnetic Oscillations in Slightly Heterogeneous Media.* **T. Carlbaum.** (Ark. f. Mat. Astron. och Fysik, Stockholm, 15. No. 16. [pp. 1–24], 1921.)—This is a mathematical article dealing with electromagnetic vibrations in a medium of feeble heterogeneity, to which a quantity of energy is originally supplied, so that the vibrations are damped. The analysis begins with an introductory part which assumes that the medium is homogeneous, *i.e.*, that the inductive specific capacity, the magnetic permeability, and the specific conductivity are independent of the coordinates of the points of space. The demonstration is conducted along the lines of Maxwell's equations and the values of the damping coefficient and the period are derived. The mathematical nature of the article does not allow of detailed abstracting. E. B.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

1462. *Literature of Thermo-E.M.F.'s in Monometallic Circuits.* **C. Benedicks.** (Ark. f. Mat. Astron. och Fysik, Stockholm, 14. No. 20. pp. 1–61, 1920.)

1463. *Determination of Electrical Resistance of Lead-Tin and Lead-Zinc Alloys at High Temperatures.* **S. Konno.** (Tôhoku Univ. Sci. Reports, 10. pp. 57–74, March, 1921. Forty-sixth report from Iron and Steel Research Inst.)—The apparatus employed is described in detail and a diagram given showing the arrangement adopted for the introduction of current and potential leads into the crucible. Full tables of results, together with graphs, are given, and the theory is discussed. From the resistance–temperature curves obtained, the equilibrium diagrams of the two series of alloys are determined, and are found to coincide almost exactly with those obtained by thermal analysis. The rate of separation of solid solution during solidification is calculated both from the resistance-temperature curves and from the equilibrium diagrams, the results showing good agreement. A. B. C. L.

1464. *Analysing Galvanometer Records.* **W. Hartree** and **A. V. Hill.** (Roy. Soc., Proc. 99. pp. 172–174, May 2, 1921.)—In recent papers, Phil. Trans. vol. 210. p. 153 (1920), the authors have described experiments in which photographic records were made of the deflection of a sensitive galvanometer registering the rise of temperature of a muscle (or other substance) resting on a thermopile. After dealing mathematically with the record the galvanometer may be expected to give under given conditions, the converse problem is faced of finding the conditions from the record. It is shown that a few trials, about three say, usually lead to a solution. It is found once for all what is the type of the curve for a quantity of heat h at time t. Then on assuming, say, heat h_1 at time t_1, h_2 at t_2, and h_3 at t_3, all with numerical values, the required result is soon reached. The method has been used in the determination of the heat produced by a muscle, which is only about 0·005 cal. per gm. E. H. B.

1465. *Experiments on the Electrical Conduction of a Hydrogen Alloy.* **D. P. Smith.** (Nat. Acad. Sci., J. 7. pp. 28–34, Jan., 1921.)—During the kathodic liberation of hydrogen on metal electrodes, two opposing effects which operate are (1) a lasting increase of resistance, and (2) a temporary diminution of resistance. The former is determined by the occluding power of the metal for hydrogen in accordance with the known properties of solid solutions in increasing resistance, and the latter may be attributed to the presence of monatomic hydrogen, unstable hydrides, or else to a temporary effect which the occluded hydrogen exerts upon the distribution or mobility of the electrons within the metal.

Experiments were made in which a palladium wire was connected as kathode in a solution of sulphuric acid. After continued electrolysis, the circuit was interrupted and the resistance of the wire was measured by a potentiometer connected by means of a Pohl commutator alternately to the ends of the kathode wire and to those of a 10-ohm. comparison resistance, an e.m.f. being applied from an auxiliary circuit. The resistance was found to vary considerably with the magnitude of the measuring current. This result tends to support the view that the temporary supplementary conduction which, in not following Ohm's law, is not of ordinary metallic character, is due to a transient form of occluded hydrogen, probably monatomic, which is confined within the cavities of the metal. J. N. P.

1466. *Uni-directional Ionic and Mixed Conductivity in Crystals.* **C. Tubandt.** (Zeits. Elektrochem. 26. pp. 358–363, Sept. 1, 1920. Paper read before the Bunsen Gesell., Halle, April, 1920.)—From the experiments described in Abs. 1502 (1921) the author concludes that the silver halides, regular silver sulphide, and copper sulphide Cu_2S conduct the current merely by migration of the kation, the anion remaining stationary, whilst in pure crystallised lead chloride only the chlorine anions migrate, the lead kations remaining immobile. These crystals would thus be either positive or negative electrolytes, the mobilities being extraordinarily high. In silver sulphide there is, further, metallic conductivity; observations have been interpreted in various ways by different previous experimenters. Above 179° the α modification of silver sulphide conducts merely as an electrolyte; below 179° the β modification is present which conducts both electrolytically and metallically. The variation in the proportions of the two conductivities with temperature is to be further studied. H. B.

ALTERNATING CURRENTS AND MAGNETISM.

1467. *Heusler Alloys.* I. *Magnetisable Alloys of Non-Magnetic Metals.* **O. v. Auwers.** (Zeits. anorg. Chem. 108. pp. 49–69, Aug. 13, 1919.)—A general discussion of dia-, para-, and ferro-magnetic properties, for the study of which the Heusler alloys of Al, Mn, Cu are a very promising material. The carriers of the magnetism of Heusler alloys are probably compounds of the form (AlM_3), in which M represents either Cu or Mn, always together present in 3 atoms to one of Al, and dissolved in copper. Whether the magnetism is due to the AlM_3 molecules, or to their complexes, or to the crystal lattice, is not certain. The freshly prepared alloy is hardly magnetic, but becomes so by ageing, prolonged heating between 100° and 300°. At red glow the carriers of the magnetism dissociate, to associate again during cooling and ageing. At 600° most of the elementary magnets are dissociated. When the intensity of magnetism is plotted as ordinate against ageing-time, the curve rises to a maximum of saturation; the coercive force has a similar curve, with a strong time lag; when the reciprocal of this latter curve is combined with the former curve, the resulting curve of magnetisation by weak fields (where the intermolecular coercive force predominates) shows a maximum in agreement with experiments. The coercive force keeps very high between 190° and 260° and increases rapidly afterwards, when the complexes begin to dissolve. Quenched from 600°, the alloy remains unmagnetic until the particles, dissociated at high temperature, have had time to associate to form elementary magnets; there is no coercive force then. Cooled slowly, the alloy shows a strong increase in coercive force. In iron the elementary magnets are pre-existent; the influence of iron on the alloys is being studied. H. B.

1468. *Magnetism of Metal-Ammonias* (*Ammines*). **E. Rosenbohm.** (Zeits. phys. Chem. 93. pp. 693–720, Dec. 2, 1919.)—G. Wiedemann observed in 1876 that cobalt, itself ferro-magnetic, gave diamagnetic ammonia compounds. The constitution of these compounds having since been cleared up by A. Werner, the author resumes the investigation studying the organic ammines of Co, Pt, Rh, Ir, Ru, Zn, Ni, Cu, Cr. He determines the magnetic susceptibility between 16 and 20° with the aid of the torsion balance of Curie. He finds the method difficult because sensitive to an extent, that very slight impurities sometimes reversed the character of the magnetisation; impurity may account for discrepancies between his own values and a few observations of Feytis. Some of the compounds examined are known in optically active enantiomorphs and in inactive (racemate) forms. In the case of the cobalt ammines the diamagnetism decreases as we pass from hexa- to penta-, tetra-, and tri-ammines; the last may be paramagnetic. In the pure ammines (containing only NH_3 and the acid rest) the NH_3 may be replaced by ethylene, propylene, even pyridine, etc.; the rule will still hold, and this applies also to the ammines of Pt, Ir, Rh, Ru, and Zn. These compounds are of the type $[Co(Am)_5R]R_2$, where Am stands for NH_3 and R for an acid rest; the R may enter from outside into the inner molecule; with the entrance of the ionogenic rest R the diamagnetism decreases. There are certain parallelities between electrolytic conductivity and magnetic susceptibility, the latter depending mainly upon the constitution of the molecule. Similar rules hold for the ammines of chromium which are paramagnetic; the susceptibility increases as we pass from the hexammine to salts without ionogenic groups; this applies, however, (by distinction from the cobalt group), not to the molecular magnetism, which, except in the racemates, has only a few, fairly constant values for the different ammines of each element. As regards the diamagnetic Co- and the paramagnetic Ni-ammines, it is noteworthy that both give di- and tri-valent salts, only the former being in general stable, but in the case of the ammines Co is stable in the trivalent state, Ni in the divalent; such valency influences are observed also in the compounds of Cu, Zn, Cr. The calculations are based upon Pascal, the theoretical considerations upon Langevin, and as regards paramagnetic compounds, upon Weiss. The magneton number is fairly constant for the ammines of each element (20 for the Cr-ammines, 9 for Cu, 16 mostly for Ni); very little can be said as to the significance of the magneton for chemical compounds. H. B.

1469. *Path of Lines of Magnetic Induction.* (Elekt. Zeits. 42. p. 292, March 24, 1921.)—It is a very widespread view that in source-free fields the lines of force must absolutely form closed curves, when they do not extend to infinity. Hadamard draws attention to this error. From the vanishing of the divergence of the vector, it may only be concluded that the sectional area of the tube of force remains unaltered, although on its return its shape may have changed. Only in special cases, namely in most simple cases such as the field round a current in a straight wire, are the lines of force closed curves. G. E. A.

1470. *Magnetic Permeability of Nickel for Hertzian Oscillations.* **R. Gans** and **R. G. Loyarte.** (Ann. d. Physik, 64. 3. pp. 209–249, Feb. 9, 1921.)—This is a German version of the work dealt with in Abs. 311, 312 (1921). The authors have extended their work so as to include oscillations of still higher frequency; in some cases also the values obtained are apparently superseded by later, more reliable figures. For nickel the following new results were obtained:—

Frequency (n) per sec.	Wave-length λ in cm.	μ^*.
$13 \cdot 16 \times 10^8$	22·8	17·17
$14 \cdot 16 \times 10^8$	21·2	11·28

NOTE.—μ^* is now used for "μ_s," the apparent permeability.

From the authors' theoretically obtained equation for the dependence of the susceptibility (χ) and the magnetic conductivity (ρ) on the frequency (n) they obtain, by inserting values for the constants [namely:

$4\pi\chi_0 = 11$; $\epsilon = 1 \cdot 3$; $n_0' = 1 \cdot 234 \times 10^9$], the value 24·3 cm. for λ_0. It is then possible to calculate the following table :—

$\frac{n_0'}{n} = \frac{\lambda}{\lambda_0'}$	$\frac{n}{n_0'}$	$\mu = 1 + 4\pi\chi$.	$\mu\gamma = \frac{2\rho}{n}$	μ^*.	$\rho \times 10^{-8}$.	λ in cm.
10	0·1000	11·92	1·434	13·43	0·885	243
6	0·1667	11·77	2·402	14·41	2·472	145·8
4	0·2500	11·48	3·633	15·66	5·607	97·2
3	0·3333	11·00	4·873	16·90	10·02	72·9
2	0·5000	9·377	7·259	19·12	22·41	48·6
1·5	0·6667	6·767	8·995	20·26	37·02	36·5
1·3	0·7692	4·850	9·423	20·01	44·74	31·6
1	1·000	0·000	8·461	16·92	52·24	24·3
0·8	1·250	−1·094	6·045	12·19	46·65	19·4
0·5	2·000	−1·094	1·814	3·952	22·40	12·2
0	∞	1·000	0	1·000	0	0

NOTE.—μ^* in column 5 is wrongly printed π^* in original.

The two last columns in this table give the magnetic conductivity as a function of the wave-length; according to the authors, this has not previously been determined. Revised figures are given for some of the constants of the elementary magnet (for Ni). Thus the moment of inertia $I = 3 \cdot 69 \times 10^{-38}$ gm. cm.^{2}; the natural frequency $n_0 = 1 \cdot 32 \times 10^{11}$; the molecular field $A = 4 \cdot 55 \times 10^6$; and the mean diameter of the magneton $D = 0 \cdot 624 \times 10^{-6}$ mm., which is of the same order of magnitude as that found for the molecular dimensions by other methods.

L. H. W.

1471. *Transverse Galvanomagnetic and Thermomagnetic Effects in Several Metals.* **F. Unwin.** (Roy. Soc. Edinburgh, Proc. 41. 1. pp. 44–49, 1920–1921.)—In a previous paper [Proc. Roy. Soc. Edin. 34. p. 208 (1914)] the author described experiments to determine the Hall-effect and the two transverse thermomagnetic effects in several metals. The fourth transverse effect (the galvanomagnetic temperature effect) was not measured then through lack of sufficiently sensitive apparatus.

In the present state of the electron theory of metals the ratios of these transverse effects to each other are of very considerable interest, and hence the value of having determinations of all four transverse effects. In the present paper a record is given of the determinations for eight different metals: Fe, Ni, Co, Ag, Cu, Zn, Cd, Al. When a strip of metal carrying a current is placed between the poles of an electromagnet and the magnet excited, it is found that there are set up between the edges of the plate a difference of potential and a difference of temperature. These constitute respectively the Hall-effect and the galvanomagnetic temperature effect. If with the above arrangement a heat current is sent along the plate instead of the electric current, it is again found that a transverse p.d. and a temperature difference are set up. These constitute the thermomagnetic "potential effect" and "temperature effect" respectively. The coefficients R and P are the values of the Hall-effect and the galvanomagnetic temperature effect in a plate 1 cm. wide placed in a magnetic field of unit strength, the potential gradient along the plate being 1 c.g.s. unit per cm. Similarly, under the same standard conditions the coefficients Q and S are the magnitudes of the thermomagnetic "potential effect" and "temperature effect," the temperature gradient along the plate being 1 deg. per cm.

The experimental arrangements were the same as those described in the author's previous paper, and it was found that the four effects have not always a common sign, but that in some cases two of the effects are positive and two negative. Zahn [Abs. 3263 (1904)] has suggested that while R and S may have different signs from Q and P, R has always the same sign as S and Q the same sign as P, so that the ratios R/S and P/Q are always positive, and this has been confirmed by the author's observations. It is found that the values of R/S and Q/P do not vary very widely from metal to metal, although the individual effects vary both in magnitude and sign. The ordinary electron theory of conduction in metals, taken in conjunction with J. J. Thomson's suggestion of a local magnetic field in the immediate neighbourhood of a molecule, is sufficient to account for the variation in the sign of the effects from metal to metal, but it cannot account for the difference between the signs of R and S, and those of Q and P, in the same metal. For this some other modification of the theory must be sought. G. H. Livens' theory of conduction in metals [Abs. 1549 (1915)] is referred to, and this statement of theory can account for at least the signs of the four effects. While the author's results are in fair accord with Livens' modification of the electron theory of conduction in metals as regards the *ratios* of the effects, they cannot be reconciled with the expressions given for the effects themselves. J. J. S.

1472. *Permeability of Nickel for Short Hertzian Waves and Arkadiev's Measurements.* **R. Gans.** (Ann. d. Physik, 64. 3. pp. 250–252, Feb. 9, 1921.)—The authors have only lately been able to obtain a copy of Arkadiev's paper [Abs. 633 (1919)], and from it find that what Arkadiev calls the permeability is what they have termed the apparent permeability [μ^*, see Abs. 312 (1921)], which is a combination of the permeability μ and the magnitude $\gamma = 2\rho/\mu n$, where ρ is the magnetic conductivity. The author's values are shown graphically together with Arkadiev's. L. H. W.

1473. *Paramagnetism of Solids.* **P. Ehrenfest.** (K. Akad. Amsterdam, Proc. 23. 7. pp. 989–992, 1921.)—The validity of the Curie-Langevin law for the susceptibility of solid paramagnetic bodies is arrived at on a different theoretical basis from that discussed by Weiss, Stern, and Lenz. It is assumed that the atoms or molecules of a paramagnetic solid contain electrons circulating in definite fixed orbits of lowest quantum number called "rest" orbits, so that there is no perceptible difference in the energy for the two opposite directions of circulation in zero field. The law is derived by expressing the time-average of the projection of the magnetic moment of the electron on the direction of the applied field. According to the theory, the Röntgen reflection of a crystal would not be changed by magnetisation. This has been established by Compton and Rogney [Abs. 535 (1921)] for crystalline magnetite. G. E. A.

1474. *Magnetic and Electrical Properties of Titanium Alloys.* **M. A. Hunter** and **J. W. Bacon.** (Am. Electrochem. Soc., Trans. 37. pp. 513–523; Disc., 523–524, 1920.)—The alloys of Ti produced within recent years are of two classes—those produced by the use of Al or Si, containing in general a high percentage of free Ti; and those produced by the use of C in which the Ti is present as titanium carbide. By the reduction of pure titanium tetrachloride with sodium, a supply of pure Ti metal can now be obtained in the form of beads which are hard and brittle, with sp. gr. 4·50 and M.P. 1800° C. Alloys were made by adding pure Ti to Norway iron and titanium alloys to Norway iron; these were tested magnetically by the du Bois balance and Burrows methods, and the results show that the presence of more than a trace of Ti brings about a lowering of the magnetisation curve. On testing ring specimens by the Rowland method, it resulted that the addition of a small quantity of Ti, which is subsequently removed, diminishes the hysteresis loss in a sample of Norway iron; if all the Ti is not removed, the hysteresis increases in proportion to the amount of Ti which remains. Silicon-iron treated with Ti gave very high permeability and low hysteresis loss. The hysteresis in these alloys increases with age, but somewhat less than that of iron. Alloys of Ti with Ni, Cu, Ni-Fe, and Ni-Cu were also made. The resistivity of these alloys was moderately high for additions of Ti up to 5 %. Beyond this point the alloys are hard to draw and they oxidise readily at high temperatures. In the *discussion*, **T. D. Yensen** pointed out that electrolytic iron had a higher max. permeability than titanium-treated iron, but that Ti seems to increase the permeability of iron at high flux density. In reply, **M. A. Hunter** emphasised that a commercial iron is improved by small additions of Ti during the melting operation, but its addition must be carefully controlled. G. E. A.

1475. *Magnetic Storm of May* 13–17. **A. C. Mitchell.** (Nature, 107. pp. 392–393, May 27, 1921.)—This storm, besides being of almost unprecedented magnitude, exhibited several unusual features, mainly in the behaviour of V, the vertical component, though the changes in the horizontal components were very large. During the "sudden commencement" at 13h. 1½m. G.M.T. May 13, a downward increase of 8γ in V was followed by an unusually rapid reversal of 31γ. Most unusual was the early occurrence, about 21h. local time, of the sudden drop immediately preceding the principal minimum of V during the first 24 hours of the storm. This is not accounted for by the theory which assigns these phenomena to the earth's rotation in a beam of particles from the sun. The outstanding feature of the second 24 hours was the occurrence of at least a dozen large and rapid oscillations in V between 1h. and 6h., May 15, the light spot being carried alternately off the top and bottom of the paper. Such have not previously been observed at Eskdalemuir. On the third day the night-fall in V persisted unusually long, only terminating a little before 7h. on May 16. M. A. G.

1476. *The Great Sun-spot Group and Magnetic Disturbances May* 8–21. **A. L. Cortie.** (Nature, 107. pp. 426–427, June 2, 1921.)—The active equatorial sun-spot which appeared on the sun's eastern limb on May 8, divided into two large spots by May 12, and the group attained max. area on May 14, when the mean heliographic coordinates were lat. + 1·4°, long. 6·4°, and lat. 0·2°, long. 358·8° respectively. During the group's passage across the sun the mean heliographic latitude of the earth was — 2·8°, and conditions were very favourable for a great magnetic storm. Slight disturbances were recorded at Stonyhurst as early as May 11, but the main storm began with a "sudden commencement" at 13h. 12m. on May 13. Details are given of the Stonyhurst records, embracing a number of unusual features including the peculiar behaviour of V during the "sudden commencement" and the early minimum reached by V on the evening of May 13, both recorded at Eskdalemuir [see preceding Abs.]. The greatest intensity occurred on the night May 14–15, and the storm did not completely subside until May 21, at 20 h. M. A. G.

RADIOGRAPHY AND ELECTROPHYSIOLOGY.

1477. *New Dry-plate for High-Speed Radiography.* **T. T. Baker** and **L. A. Levy.** (Phot. J. 61. pp. 158–166; Disc., 166–168, April, 1921.)—The authors point out that improvement in X-ray photographic plates allows the distance between the X-ray tube and plate to be increased and in this way much better definition to be obtained. The need for rapidity in photographing moving objects such as lungs, etc., has led to the intensifying screen of calcium tungstate, which by fluorescing allows of a shorter exposure. The present paper is concerned with a special type of photographic plate which itself has a layer of calcium tungstate, so obviating the necessity of using a screen. Such a plate is stated by the authors to be considerably cheaper, and to be 30 or 40 times as efficient. The fluorescence spectrum of calcium tungstate is then discussed: the X-rays excite the upper tungstate layer to fluorescence, and this in turn affects the deeper silver-bromide layer of the plate. The applications of this plate to medical and technological purposes, and its manufacture, are then dealt with in detail, some specimen photographs being given, which certainly show, for X-ray work, extremely good definition. B. J. L.

1478. *Experimental Data and Standards for X-ray Dosage in Radiography and Radiotherapy.* **F. M. de Laroquette** and **S. Millot.** (Comptes Rendus, 172. pp. 525–527, Feb. 28, 1921.)—Deals with relative tests carried out on various old and new methods of standardising X-ray doses, such as photographic, biological, physiological, and pastille methods; these are discussed in detail. The absorption of the rays was determined by the use of lard, which has the advantage of being homogeneous, and figures are given for the progressive absorption. The coefficient of absorption is defined in terms of thickness of aluminium plates, and, roughly, 1 mm. of Al is equivalent to 1 cm. of tissue. From their results the authors have evolved a graphical scale which they describe; this scale enables the time of exposure for any given case to be predetermined. B. J. L.

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CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

1479. *Spiral Classification of the Elements.* **L. Tansley.** (Chem. News, 122. pp. 121–122, March 18, 1921.)—The spiral arrangement suggested by the author is described, and its advantages are pointed out. The 18 sub-groups are allotted 20° each of the complete circle. The atomic weight 240 is at the centre, and the other elements are plotted as they decrease in weight, each being placed on a radial line at its correct value, concentric circles of increasing radii having first been drawn to act as a guide in plotting. L. H. W.

1480. *Action of Nitrogen on Platinum in Presence of Nickel.* **F. Wolfers.** (Arch. des Sciences, 2. pp. 410–411, Sept.–Oct., 1920. Paper read before the Soc. Suisse de Physique.)—When oxygen is not present, nickel is attacked by nitrogen at 300°; a volatile nitride is formed which becomes unstable at 600°. This nitride attacks platinum very strongly, rendering it brittle and crystalline. For the same reason, no platinum thermo-couple should be used in a nitrogen atmosphere at temperatures about 500° if there is any nickel in the vicinity. L. H. W.

1481. *Magnetic Reluctivity Relationship as Related to Certain Structures of Eutectoid Carbon Steel.* **C. Nusbaum, W. L. Cheney,** and **H. Scott.** (Bureau of Standards, Bull. 16. pp. 739–759 [Sci. Papers, No. 404], 1920.) —The close relationship existing between the heat treatment and the magnetic properties of iron and steel, as well as between their heat treatment and mechanical properties is becoming recognised as very important. Changes in the physical properties resulting from thermal treatment generally indicate certain transformations and changes in structure, and have been studied in the case of 1 % carbon steel, as a result of which it has been shown that a very rapid rise of the maximum and residual induction and an even more pronounced decrease in the coercive force occur between the drawing temperatures of 150° and 250° C. Such changes probably mark the transformation from martensite to troostite. In the present investigation, a eutectoid steel containing 0·85 % carbon has been used so that the arrangement of the constituents may be as simple as possible. The term reluctivity is the ratio, magnetising force/magnetic induction. The reluctivity relationship is considered for eutectoid steel, and the stages of magnetisation are illustrated. The characteristics of the reluctivity line for pure materials, impure materials, and complex structures include the different arrangements possible with the constituents of carbon steels—namely: (1) parallel arrangement in which the alternate layers of cementite and ferrite are all parallel to each other, and to the direction of the effective magnetic field; (2) series arrangement in which the lamellæ of cementite and ferrite are oriented parallel to each other and perpendicular to the direction of the effective magnetic field, and (3) spheroidal arrangement in which the patches of pearlite are irregularly distributed through ferrite. The conclusions arrived at as a result of the work described are that the very rapid rise of the max. induction of hardened steel at 150°–250° C., accompanied by heat evolution, indicates that cementite is thrown out of solid solution in martensite; it also indicates the completion of a previously suppressed transformation which may be considered as the beginning of the constituent troostite. The magnetic inhomogeneity within the temperature range 0–230° C. may be due to the presence of another constituent or to the stresses set up during previous quenching. Between 230° and 460° C. the material is magnetically homogeneous. This is in favour of Benedicks' theory of troostite, that is, it shows that the cementite is distributed very uniformly in very finely-divided particles throughout the whole mass of ferrite. Between 460° and 700° C. the material is magnetically non-homogeneous: this is due to the increasing size of the aggregate and to their approaching stratification. The transition point between these two ranges of temperature may be considered as the beginning of sorbite. The magnetic reluctivity relationship is thus shown to provide a method for magnetically differentiating the metallographic constituents of the iron-carbon series. C. O. B.

1482. *Making Metal Tubes Resistant to Water Vapour at* 1000° C. **P. Askenasy.** (Zeits. Elektrochem. 26. p. 436, Oct. 1, 1920. Paper read before the Bunsen Gesell., Halle, April, 1920.)—Iron tubes are oxidised to Fe_3O_4 when exposed to steam at 1100° for weeks. Silicon-iron will resist the water vapour, but is brittle and cannot bear thermal strain. The author had silicon-iron rolled down to sheets 2 mm. in thickness by Capito and Klein; the sheets were cut in strips while hot, and an experienced boiler hand twisted the strips over a mandrel to tubes, welding the seam with scrap from the mill. These tubes are directly used as resistors or wound with resistance. They bear also hot air and mixtures of oxygen with water vapour at high temperatures, and have been used in the preparation of magnetite electrodes by heating soft iron in steam at 1000° to 1100° (German Pats. 235,307, 254,560, 255,072); pieces of pure baked alumina or of dynamidon are placed between the tube and the iron to prevent their fusing together. The tubes also serve as superheater for water or steam, iron being cast or welded round the tubes to increase the strength. H. B.

1483. *Photomicrographs of Steel at High Magnification.* **R. Hadfield** and **T. G. Elliot.** (Faraday Soc., Trans. 16. pp. 156–161, Sept., 1920.)—A review of the early history of photomicrography and a discussion on a number of photographs of steel under various magnifications, the highest of which is 8000 diameters, these high magnifications being obtained by means of a 1·5-mm. apochromatic objective and a large camera extension. J. L. H.

1484. *Use of Ammonium Persulphate for Revealing the Macrostructure of Iron and Steel.* **H. S. Rawdon.** (Bureau of Standards, Bull. 16. pp. 715–723 [Sci. Papers, No. 402], 1920.)—Gives reproductions of photomicrographs to show the value of ammonium persulphate as a revealer of crystalline heterogeneity and chemical inhomogeneity in iron. Various features are revealed by this means which would be missed if other etching agents were employed. L. H. W.

1485. *A Thermoelectrical Differential Method for the Determination of Transition Points of Metals at comparatively Low Temperatures.* **A. Smits** and **J. Spuyman.** (K. Akad. Amsterdam, Proc. 23. 7. pp. 977–

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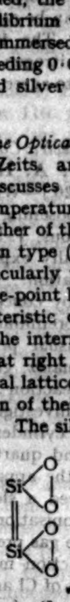
979, 1921.)—The occurrence of transition points in copper at temperatures between 0° and 100° C. was investigated by forming a junction with silver and connecting in the following chain: Cu II—Cu I—Ag—Cu I—Cu II. Cu II consists of copper wires leading to a potentiometer and Cu I of wires of pure copper. The junctions between Cu I and Cu II were maintained at 0° C. in an ice bath, and those between Ag and Cu I in separate tubes, one containing paraffin oil and the other a solution of copper sulphate, placed in the same thermostat.

The procedure is based on the assumption that when any transition point of silver or copper is reached, the junction in the electrolyte with which it is in electromotive equilibrium will be sooner transformed than the same combination which is immersed in the paraffin. It was found that, in no case, was an e.m.f. exceeding 0·001 volt obtained, thus indicating homogeneity of both copper and silver over the range of temperature employed. J. N. P.

1486. *Atomic Grouping and the Optical Rotation of Quartz and Sodium Chlorate.* **J. Beckenkamp.** (Zeits. anorg. Chem. 110. pp. 290–310, April 29, 1920.)—The author discusses chiefly quartz, christobalit, and tridymit, and the influence of temperature on these modifications and on their twinning. The twins are either of the Dauphinée type (both crystals of a pair alike) or of the Brasilian type (the two crystals differing as the left and right). Referring particularly to Groth, Sohncke and W. H. Bragg, he conceives that the three-point helix is due only to the introduction of oxygen and not characteristic of silicon. The spiral grouping of the layers at right angles to the intermediate axes goes together with a spiral arrangement for layers at right angles to the main axes. The silicon atoms form a rhombohedral lattice; the disposition of the oxygen atoms is such that the orientation of their valency directions is the same in horizontal and vertical layers. The silica molecule is probably double,



with the 2 Si vertically above one another. In the right- and left-handed crystals the molecules are enantiomorphs of one another. Heating favours twinning of the Dauphinée type, not of the Brasilian type; that indicates that the Si and O of the same molecule are more strongly linked and less easily displaced than two molecules are. H. B.

1487. *Molecular Attraction.* III. *The Characteristic Equation.* **K. K. Järvinen.** (Acad. Sci. Fennicæ, Ann. 1919 (A) 44 pp.)—Further considerations starting from a formula of the type $F = Km^2/r^n$ for the molecular attraction [Abs. 472 (1916)]. The value found for the internal pressure is much smaller than that calculated from van der Waals; the critical pressure is also considered. Though approximate accuracy is only claimed by the author for his deductions, he concludes that the theory is so far incomplete.

IV. (Zeits. phys. Chem. 93. pp. 737–742, Dec. 2, 1919.)—From thermal considerations the author concludes as in the previous papers that the most likely value for the exponent *n* of the force formula is 5, both for monatomic and polyatomic molecules. He takes his data from various investigators. H. B.

1488. *Calculation of the Saturation Pressure from Temperature, Heat of Vaporisation, and Molar Volume of the Liquid, with the Aid of Maxwell's Distribution Law.* **K. K. Järvinen.** (Zeits. phys. Chem. 93. pp. 743–753, Dec. 2, 1919.)—Kinetically equilibrium between a liquid and its vapour will arise when in unit time the same number of molecules leave and enter the liquid. From these numbers and the energies transported the saturation pressure can be calculated with the aid of Maxwell's distribution law of velocities. The formulæ deduced are applied to mercury, and also to oxygen, nitrogen, benzene, ether, methylbutyrate, pentane and toluene, and found to agree quite as well as might be expected with the accepted data. H. B.

1489. *The Constancy of the Electric Conductivity of Gases during Chemical Reactions.* **M. Trautz** and **F. A. Henglein.** (Zeits. anorg. Chem. 110. pp. 207–289, April 27, 1920.)—Whilst Lenard, Trautz, and others believe that there is merely a loosening of the electrons in the molecules or atoms during chemical reactions, J. Stark, J. J. Thomson, and others suggest that electrons are actually expelled and that chemical reaction should be accompanied by ionisation. The authors study purely gaseous reactions, not to be influenced by concomitant or subsidiary phenomena (radiation, water spray). In preliminary experiments they convinced themselves that, with the unusual precautions taken, the container-materials used, ground glass, quartz, graphite, and paraffin, did not influence the velocity of the reaction: $2NO + Cl_2 \rightleftarrows 2NOCl$, which they had already studied and investigated again. The apparatus is a condenser formed by two glass cylinders, the one within the other, insulated by means of paraffin and quartz; the inner cylinder walls are covered with graphite. When the apparatus was charged with dry air, the ionisation of that air showed a slow, slight increase, rising within 4 hours to a maximum; this ionisation was probably due to imperfect insulation; it increased with the gas pressure and was greater in chlorine than in air. In the NOCl reaction mentioned the ionisation was not any stronger than with mixtures of Cl and N; the observation of Pinkus that an excess of chlorine favours the formation of ions is not supported. Nor were any ions produced during the reactions $2NO + Br_2 \rightleftarrows 2NOBr$ and $2NO + O_2 = 2NO_2$. The same applies to the reactions $2NBr + Cl_2 \rightleftarrows 2HCl + Br_2$ and $Cl_2 + H_2 \rightleftarrows 2HCl$, so that the authors conclude in general that gaseous reactions do not produce ions, at least not at the temperatures of the experiments. H. B.

1490. *Heating-Curve Study of Rapid Low-Temperature Reactions: Barium Oxides.* **J. A. Hedvall** and **N. v. Zweigbergk.** (Zeits. anorg. Chem. 108. pp. 119–136, Sept. 11, 1919.)—Hedvall [*ibid.*, 104. pp. 163–168, 1918] had shown that while pure barium peroxide BaO_2 decomposed into oxide and oxygen at 800°, it liberates oxygen already at 200° in the presence of silica. He assumed that the BaO in status nascendi has a strong affinity for SiO_2, and that the affinity increases as the temperature is raised, until the formation of a protective layer of silicate checks the reaction. In the present paper it is shown that similar catalytic reactions take place in the presence of a great number of oxides (not only of acid character), and that there may be decomposition of the peroxide without formation of a compound. The experiments are made with masses of about 5 gm. in porcelain crucibles, heated in gas furnaces, temperatures being measured every 10 seconds by thermal couples. Of the oxides investigated, SnO, SnO_2, ZrO_2 had no effect. A purely-catalytic oxygen liberation, without chemical reaction, was observed with CuO, MgO, CaO, CdO; mixed crystals might be formed. The oxides Ar_2O_3, Sb_2O_3, Cr_2O_3, Fe_2O_3, the various oxides of Mn, Ni, Co (?) were themselves higher oxidised; in the cases of Cu_2O, V_2O_5, Sb_2O_3, Cr_2O_3, MnO_3, MnO, the reaction velocity became enormous between 200° and 300°. Alumina gave aluminate; lead oxide (litharge) did not liberate oxygen until near 500°, yielding a barium plumbate. H. B.

1491. *The Influence of the State of Division on the Melting-Point.* **F. Meissner.** (Zeits. anorg. Chem. 110. pp. 169–186, March 12, 1920.)—Criticising the method of Pawlow [see Abs. 1523, 1524 (1910)] of determining the influence of grain size on the melting-points and the results obtained, the author points out with Tammann that the surface energy depends upon the method by which the disruption was effected and he makes use of the apparatus for the melting-point determination of Tammann [see next Abstract], which he describes. In the cases of azobenzene, tristearin, and myristic acid, the boundary curves between the solid and liquid portions were displaced towards the cold end of the iron plate; *p*-chloraniline and stearic acid showed no displacement. As the thickness of the lamella changed from 0·8μ to 10μ, the melting-point of myristic acid rose by about 0·5°; salol and Glauber salt gave changes of the same order, azobenzene higher values. Stationary curves were obtained only with substances, the melting-points of which lie between 50° and 80°. Calculations of the surface energy are indicated. H. B.

1492. *Relation between Melting-Point and Thickness of a Crystal Lamella.* **G. Tammann.** (Zeits. anorg. Chem. 110. pp. 166–168, March 12, 1920.)—The melting-point will be influenced by the thickness of the lamella and by the way in which the lamella is prepared, and the work of disruption done upon it. The lamella may be split off by cleavage, or prepared by crystallisation of a previously liquefied layer, in which case the original orientation will play a part, or by powdering the crystal. The author recommends to produce by crystallisation a layer of varying thickness between a cylindrical lens and a metal plate, in which a temperature gradient is maintained such that the line of contact is perpendicular to the isotherms in the plate. As the thickness of the lamella is not constant, the boundary between the melting and the still solid substance will not be a straight line, but a curve. When the thickness of the lamella and the temperatures at various points of the curve are known, the relation between thickness and melting-point can be determined. The work required to disrupt the crystal and the influence of the lamella thickness on the melting-point will both be inversely proportional to the thickness, and it is shown thermodynamically that the work of disruption is equal to the change of the equilibrium temperature multiplied by the entropy of unit mass at the melting-point [compare Meissner, preceding abstract, as to apparatus]. H. B.

1493. *Derivation of Chemical Affinity from the Electron Theory.* **H. Teudt.** (Zeits. anorg. Chem. 108. pp. 137–160, Sept. 11, 1919.)—Further development of the author's views [Abs. 544 (1921)] to explain the formation of molecules and compounds. In the first horizontal row of the periodic system each element has one system of inner electrons, an element of the second row has two systems (each of the same number of electrons), and so on; the valency electrons are outside these rings, and the number of valency electrons is constant for all the elements of the same vertical column. The inner electrons rotate on spheres in almost equatorial orbits; the poles of the sphere remain free from electrons, and the larger these unoccupied polar regions the more positive lines of force will be able to stretch over to the valency electrons of another atom.

The grouping of the atoms in a molecule may be uniaxial (the nuclei lying in one axis) or of a radial type (several axes); the latter linkage will be weaker than the former. But there are also other forces. The different rings, and also the valency electrons, may attract and repel one another owing to their orientation; the repulsion will increase with the number of valency electrons, as they are more closely packed; hence organic compounds break up easily at double bonds. For these reasons also metalloids generally form polyatomic molecules, whilst metals are monatomic in vapours and in diluted solutions. Hydrogen has only a valency electron, but no inner electron system; as its positive nucleus lies directly opposite the electrons of metals, hydrogen behaves in many compounds like a metal, but differs from metals because the positive field of hydrogen is pre-existent; whilst the field has to be produced in metallic atoms by the displacement repulsion of the electrons in the nucleus. In two atoms of metalloids facing one another positive and negative spots will alternately be opposite; the valency atoms will hence describe a wave curve between the two atoms, and these oscillations may explain the odour of compounds which is not characteristic of the element and changes with the nature of the compound. H. B.

1494. *Purification of Liquefied and Compressed Gases for the Laboratory.* **L. Moser** and **W. Foltz.** (Zeits. anorg. Chem. 110. pp. 125–142, Feb. 24, 1920.)—Carbon dioxide, produced from coke-oven gas, is much used as indifferent gas, and has to be freed from oxygen, in the dry, by passing the CO_2 over glowing copper, or in the wet with the aid of chromium chloride or acetate (in paste), and further with titanium trichloride; the statement that CO_2 might, in the dry purification by glowing copper, be reduced to CO is not confirmed. Any CO in the CO_2 is oxidised by passing the gas over asbestos coated with copper oxide. Commercial nitrogen (Linde) is generally very pure, apart from the rare gases and oxygen (removed by copper wire gauze in ammonium carbonate). In electrolytic hydrogen CO is the most objectionable impurity, also because the compressed gas attacks the steel under formation of $Fe(CO)_5$ which is apt to yield CO again during its decomposition by heat and concentrated sulphuric acid. The carbonyl is not often found, but 3 % have been observed in steel cylinders, which should be enamelled inside. Commercial chlorine, now practically all electrolytic, is purified by liquefaction. H. B.

1495. *Scandium: its Atomic Weight and Compounds.* **R. J. Meyer** and **B. Schweig.** (Zeits. anorg. Chem. 108. pp. 303–317, Oct. 24, 1919.)—Having shown (*ibid.*, 86. p. 257, 1914) that the accepted atomic weight

44·1 must be questioned, the authors find that the traces of thorium, yttrium, etc., in scandium can be eliminated by fractional crystallisation of the scandium formate or the salt $(NH_4)_3 ScF_6$. The authors agree that the sulphate method is unsuitable for the determination of the atomic weight; Hönigschmid's determination Sc = 45·1 [Abs. 548 (1921)] was made with material supplied by the authors and by J. Sterba Böhm.

H. B.

1496. *The Reversible Reaction Iron-Steam.* **E. Schreiner** and **F. B. Grimnes.** (Zeits. anorg. Chem. 110. pp. 311–334, April 29, 1920.)—The equilibrium pressures of water vapour and hydrogen in the presence of iron are studied with an apparatus after Deville. Equilibrium was obtained equally rapid with free and with forced circulation; the improved circulation of L. Wöhler would hence be inessential. So far as data are available, the thermochemical and thermodynamical calculations are in accord; the discrepancies of different investigators are probably due to the formation of solid solutions between iron and ferrous oxide and to modifications of the solid phases, which require further study. Details are given for the range 595° to 920°; at still higher temperatures the discrepancies between the various workers become more marked.

H. B.

1497. *Micrometallurgy of Silicon Alloys.* **S. Bogdan.** (Soc. de Chim. România, Bull. 1. pp. 60–72, 1919.)—As long as the silicon percentage in iron and copper is very small, the alloys appear to be homogeneous solid solutions. When the Si exceeds 1 %, crystalline compounds, probably silicides, make their appearance in the solid solutions. When the Si exceeds 4 %, the embedded crystals may represent two silicides, and silicon itself is found both crystalline and amorphous. With still higher percentages the whole mass becomes more crystalline, harder, and more brittle. The separation of the compounds is facilitated by prolonged heating of the alloys. Alloys rich in Si, especially copper alloys with more than 10 % of Si, were particularly studied; the preparation of the alloys is not described.

H. B.

1498. *Heat of Solution.* **G. Tammann.** (Zeits. anorg. Chem. 109. pp. 215–220, Jan. 16, 1920.)—The heat of solution is made up of the heat required I. for the conversion of an anisotropic substance into an isotropic liquid; II. the mixture of the solute with the solvent; III. any chemical changes and ionisation. The values of I and II can be calculated and frequently be estimated by experiment; the heat Q_c of III can in general not be stated *a priori*. From the determination of the heat of fusion we may at once be able to see that III effects are present; it must not be supposed, however, that chemical effects are absent, because Q_c is found to be zero; for there may be chemical processes which compensate one another.

H. B.

1499. *Theory of Electrolytic Ions. XI. The Limiting Values of Molar Conductivity and their Determination.* **R. Lorenz.** (Zeits. anorg. Chem. 108. pp. 81–100, Sept. 11, 1919.)—The limiting value μ_∞ may be calculated after Ostwald-Bredig, $\mu_\infty = \mu + \Delta$ where Δ varies with the dilution at which μ is observed (only univalent electrolytes, Na and Cl-compounds, studied), and after Kohlrausch, who gives one formula for very high dilutions: $\mu_\infty - \mu = a[S_0]^{1/2}$, and a similar formula $\mu_\infty - \mu = b[S_0]^{1/3}$ for less high dilution; the S_0 are the concentration, and the formulæ differ as to the exponents and the constants *a* or *b*. Kohlrausch experimented with a large number of organic salts of the ammonium type. Analysing the data of Bredig and of Kohlrausch by graphic and algebraic methods, the author is unable to decide between the two types of formulæ.

XII. *The Limiting Value of the Molar Conductivity and the Kohlrausch Extrapolation* (*ibid.* 108. pp. 191–210, Oct. 1, 1919).—Bredig's figures were given in Siemens units—they are often quoted without conversion, as the author points out—and his Δ were empirical. Calculating the Δ from Kohlrausch's first formula, the author concludes that the Ostwald-Bredig rule can only be accepted as an approximation. Kohlrausch's rule is preferable, the *a* formula to be used for dilutions from 10,000 to 100, the *b* rule for 100 to 10; a more general formula would be $\mu_\infty - \mu = A[S_0]^n$ where A and *n* depend upon the concentration. In series of organic univalent kations the *a* and *b* retain their value throughout the series, being group constants; in inorganic salts, however, the *a* and *b* are individual and increase in the alkali group as we pass from Li to Cs. Reference is made to Washburn. H. B.

1500. *Potential Changes by Ultra-Violet Light on Oxidising Agents* (*Dichromate*). **T. Swensson.** (Ark. Kem. Min. Geol., Stockholm, 7. 12. pp. 1–12, 1917.)—First account of researches described more fully in the paper of Abs. 1113 (1920). When mixtures of potassium dichromate and sulphuric acid are illuminated by a quartz-mercury lamp at 18°, potential changes occur. The electrodes, bright or platinised platinum, need not themselves be illuminated; in the mixture of dichromate and sulphuric acid the potential rises, in the separate solutions of the components it falls, and it falls also when chromic acid is illuminated; the liberation of this chromic acid is not essential, therefore, for the rapid first effect. H. B.

1501. *Molecular Condition of Liquids and Solutions.* **E. Kröber.** (Zeits. phys. Chem. 93. pp. 641–692, Dec. 2, 1919.)—An extension of the work of the late Mühlenbein on the internal friction of non-electrolytes, making use also of the data of Dan Tyrer [Abs. 1277 (1911)] and others, dealing with the density, expansion, and compressibility of a very large number and variety of solutions of liquids in liquids, and also of solids in liquids or solids. The (few) solid solutions are prepared by fusing the materials together; some solutions may have been mixtures only. All the materials, except water and carbon disulphide, were organic; observations are made at 25°, with the solids also at other temperatures; most of the data are new. The tables concern solutions of many solutes in the same solvent, and of the same solute in many solvents, and the mutual replacements (of solvent and solute) observed. In the case of liquids the number of replaced mols will only be approximately equal if solvent and solute are closely related, *e.g.*, benzene and its bromo derivatives; the displacement ratios are approximately those of the molecular volumina, and depend little upon the concentration of the solute and the nature of the solvent. The volume changes (in liquids) are small, and distinct influences of solvents or of solutes cannot be separated; the volume changes observed on dissolving solids in liquids are larger, mostly positive, and characteristic influences of solvent and of solute can be traced.

The coefficients of expansion and of compressibility run fairly parallel to the mean atomic concentration, *i.e.*, the reciprocal of the mean atomic volume, which seems to be more suggestive for certain researches than the molecular volume. In homologous series the atomic concentration at boiling-point is nearly constant, and for other substances, consisting only of C, H, O, it varies only within rather narrow limits. From the expansion coefficients and other properties of the components of mixtures it would appear possible to predict whether contraction or dilatation should occur; in the few exceptional cases chemical reactions seem to interfere. H. B.

1502. *Electric Conductivity of Solid Crystallised Compounds. I. Verification of Faraday's Law in the Electrolysis of Solid Salts of the Heavy Metals.* **C. Tubandt** and **S[ophie] Eggert.** (Zeits. anorg. Chem. 110. pp. 196–236, March 12, 1920.)—Solid salts might conduct electrolytically as such or owing to the presence of moisture and impurities, or as metals. The decision is often rendered very difficult because threads of the electrode metal form conducting bridges through the salt. Cubic silver iodide, electrolysed with a silver anode and platinum kathode, deposits silver in a fairly coherent form without developing conducting threads, and a layer of this salt is hence interposed between the kathode and the other salt to be studied. In the investigation of this AgI itself, the salt is either fused in a test tube, a cylindrical platinum kathode and a silver rod being inserted; or a compressed cylindrical block of the salt is applied with foil electrodes which are pressed on. In the latter case the silver anode subsequently appears scooped out. In the case of hexagonal silver iodide, a layer of the cubic iodide is interposed between the kathode and the hexagonal salt. Both these salts obey Faraday's law within 1 % and less, as is shown by determining both the anode loss and the kathode gain. The silver iodide is trimorphous. The fused salt gives at 552° cubic crystals, which at 144·6° pass into the hexagonal form; under high pressure (above oxidation) both modifications pass into a third insufficiently studied modification. The cubic AgI is a very good conductor, the specific conductivity rising from 1·31 to 2·64 (solid, 2·36 fused); the hexagonal salt is a very poor conductor, the specific conductivity just before reaching the transition point being only 0·00034. Both silver chloride and silver bromide are short-circuited in a few minutes during electrolysis, when a layer of silver iodide is not interposed as indicated; the two layers of the salts may be pressed together or fused together. Silver nitrate, hardly conductive at ordinary temperature, is difficult to investigate by the interposition of iodide; but it follows Faraday's law. In the case of the lead halides the equilibria of the systems $PbCl_2 - AgCl$, $PbBr_2 - AgBr$, $PbI - AgI$ had first to be studied; they form eutectics, and there is the compound $2PbBr_2 . AgBr$, and possibly $PbI_2 . 4AgI$; details and diagrams are given. Lead chloride gave the correct anode effect, but kathodically too little Pb was deposited, probably owing to the formation of a lead subhalide which turns red or violet when exposed to light. There were also reactions between the lead and silver salt. In the case of the cuprous iodide metallic short-circuiting threads were not observed, but in the combination with AgI iodine was deposited at the junction between the two salts, and the resistance increased. In the cases discussed Faraday's law thus seems to hold, but there are cases of mixed, metallic and electrolytic conductivity. H. B.

1503. *On the Velocity of Unimolecular Reactions.* **E. K. Rideal.** (Phil. Mag. 40. pp. 461–465, Oct., 1920.)—The reaction velocity of a unimolecular reaction is given by the expression $dn/dt = \nu e^{-h\nu/kT}$, where ν the activating radiation frequency is identical with the time of molecular relaxation. On the basis of the radiation theory light would appear corpuscular, the size of a quantum being equal to a wave-length of light. If its energy be due to an electrostatic charge E, then $E^2 = 2hc$. AUTHOR.

1504. *Osmotic Pressure Regarded as a Capillary Phenomenon.* **H. Hulshof.** (K. Akad. Amsterdam, Proc. 23. 1. pp. 184–192, 1920.)—An attempt is made to give an explanation of osmotic pressure by regarding this pressure as the consequence of capillary actions. The paper is entirely theoretical. L. H. W.

1505. *Electromotive Force of Alloys of Cadmium or Zinc with Tin, Lead, or Bismuth.* **P. Fuchs.** (Zeits. anorg. Chem. 109. pp. 80–88, Oct. 11, 1919.)—In amalgams the potential will, within concentration ranges of only one phase, change continuously with the composition. When two phases occur, the potential is independent of the composition. This rule has been generalised; but according to Tammann (*ibid.*, 107. pp. 1–136, 1919, Properties of Mixed Crystals and their Atomic Structure) this is admissible for alloys only within the temperature range, in which an interchange in the positions of the atoms can take place in the crystal lattice so that the alloy can enter into equilibrium with the electrolyte. This temperature range is not reached for most alloys at ordinary temperature. In their case the potential of a series of mixed crystals will be independent of the concentration, as in a two-phase range. Where there is a gap in the series the potential may change discontinuously. These views are confirmed by the author. He prepares his alloys by fusing 10 gm. of each metal in a hydrogen atmosphere; the electrodes are heated for 20 hours to about 30° below melting-point. The cells consist of the alloy, *e.g.*, of Cd, of normal $CdSO_4$-solution, and a Cd kathode. Owing to the formation of basic compounds, the potentials do not become steady for many hours, and measurements are continued for 4 days and more. The potential generally falls in the course of time; with Bi-Zn it is very small at first and rises slowly. Reference is made to Herschkowitsch. H. B.

1506. *Silver Anodes in Caustic Alkali: Disgregation of Oxidation Products.* **F. Jirsa.** (Zeits. Elektrochem. 25. pp. 146–151, May 1, 1919.)—When a silver anode is polarised in caustic potash by direct current, the addition of telluric acid causes a temporary depolarisation; alternating currents depolarise permanently when superposed on the polarising direct current. Polarisation by alternating current (49 periods) alone oxidises the Ag anode. Direct-current electrolysis leads to the formation of a colloidal oxidation product Ag_2O_2 which passes into suspension; in the presence of telluric acid this product is probably Ag_2O_3; electrolysis by alternating currents yields Ag_2O. H. B.